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THE THIRD MISSISSIPPI RIVER BRIDGE, at St. Louis, is again under discussion by the stockholders. Chief Engineer A. G. Tullock, of Leavenworth, Kan., describes the proposed bridge as having seven steel spans, resting upon six river piers, resembling in general design the Merchants' Bridge. The bridge company has been chartered under the laws of Illinois, with $300,000 capital, and it is now proposed to increase the capital stock to $2,000,000. The Government Engineers have yet to approve of the location; and this location is not yet made public, except in a general way, for reasons of land condemning and finances.

AT THE NEW EAST RIVER BRIDGE, the caisson for the Brooklyn tower foundations was successfully launched, on Dec. 15, from the yard of the Degnon-McLeod Construction Co. The launch was witnessed by a number of prominent invited guests, and after launching the caisson was at once towed into position for sinking.

MOVING A BRIDGE PIER is a feat which is said to be in progress by the engineers of the Northern Pacific R. R. According to press reports, one of the piers of the bridge over the Missouri River at Bismarck, No. Dak., has been moved laterally several feet. The span has been supported on falsework, and it is proposed to move the old pier back into position, and lower it at the same time to a more stable foundation.

WORK ON THE NEW YORK STATE CANALS has been resumed. At present the total mileages of canal work completed, under contract, and to be placed under contract are, respectively, as follows:

	Completed. Miles.	Under contract. Miles.	Contracts not let. Miles.	Total length. Miles.
Eastern division...	4.38	50.17	51.68	106.237
Middle " ...	....	97.023	.....	97.023
Western " ...	....	112.16	35.613	147.773
Total Erie Canal...	4.38	259.353	87.3	351.033
Oswego Canal.....	3.07	4.23	31	38.3
Champlain Canal...	4.3	25.62	35.08	65
Grand total.....	11.75	289.203	153.38	454.333

A portion of the lock work has been completed on both the middle and western divisions of the Erie Canal. About 6,000 men are now estimated to be at work on the various contracts.

A CHICAGO DRAINAGE CANAL, suggested by Mr. H. B. Hurd at a meeting of the city council of Evanston, Ill., Dec. 14, provides for a canal from Lake Michigan, at Grosse Point, north of Evanston, to the North Branch of the Chicago River at Lawrence Ave. This would include Evanston, Niles, Winnetka, Kenilworth and Wilmette in the main drainage system, and would require only a 9-ft. intercepting sewer on Lawrence Ave., instead of the 17-ft. sewer and feeder proposed by the drainage board. The pumping plant for the interceptor would also be correspondingly smaller. This plan is based on the plan of the commission appointed when Mr. Swift was Mayor of Chicago, the commission including Gen. Wm. Sooy Smith, Geo. H. Benzenberg, Joseph Downey, Samuel G. Artingstall and L. E. Cooley. It seems not improbable that some such canal may be built, as Mr. Boldenwick, the new President of the Chicago Sanitary District, suggested in his first address that the north branch of the Chicago River should be extended to the city limits, at least, and then connected with the lake by a canal. A pumping plant would be established to create a current in the canal, and a lock could be provided to pass vessels from the level of the lake to the higher level of the canal.

THE NEW YORK STATE CANALS improvements, it is now estimated, will cost $5,000,000 in addition to the $9,000,000 already expended or called for by existing contracts. According to a statement recently made public by State Engineer Compbell W. Adams, the expenditures on the canal improvements up to Nov. 15, 1897, had been as follows:

Paid to contractors	$3,550,519
Advertising on contracts let	84,163
Advertising on work not begun	3,845
Inspection on contracts	62,702
General inspection	9,461
Engineering	553,000
Total	$4,263,490

The balance due on contracts now under way is $3,229,188, and contracts are soon to be let for work estimated to cost $1,086,109, making a total of $8,578,788. The work which remains to be done is the deepening of about 153 miles of canal prism, mostly on the Oswego and Champlain canals, a large amount of lock work, including the proposed pneumatic lift lock at Lockport, N. Y., and various miscellaneous work. It is for this additional work that the additional $5,000,000 is required. Like the first $9,000,000 appropriation the expenditure of this sum will have to be approved by popular vote, and at the coming session of the State Legislature a bill will be introduced, which will authorize the proposition to be submitted to the people at the general election of 1898. In our issues of Sept. 2, 16 and 23 the work of the New York State canals improvement was described at some length.

THE IMPROVEMENT OF THE CHICAGO RIVER is now again being publicly discussed, in its important relation to the commerce of the port of Chicago and also as a means of supplying the amount of water to be required for the drainage canal. The general trend of public opinion is probably in favor of undertaking the improvement on a bold scale, by widening, deepening and straightening the river and replacing swing bridges by bascule bridges. One of the most difficult pieces of work would be the lowering of the tunnels which now carry cable railways under the river, but it is suggested that the tunnels might be abandoned and the traffic transferred to the bridges. On the other hand, the old scheme of filling up the river and establishing a lake front harbor is being brought to light again, mainly at the instance of the cable railways, which foresee great expense if Congress should establish a depth of 21 ft. instead of 16 ft. for the Chicago River. It is even suggested (by the railway interests) that the new Lake Front Park should be incorporated with a great lake front harbor project, but it is very improbable that the public will consent to abandon the available water front to harbor purposes. Another movement started on the West and North Sides calls for river improvement and fixed bridges. The Calumet Harbor project is not being resuscitated, and, in fact, Major Marshall, U. S. A., the government engineer in charge of the district, has abandoned his former recommendations of this harbor, and in his latest report has recommended the radical improvement of the Chicago River.

THE INTERCEPTING SEWERS which are to connect the sewerage system of Chicago with the main drainage canal have again been under discussion by the city authorities and the drainage board. It has been practically decided that the city will build two sewers, one 16 ft. diameter, from the lake, along Lawrence Ave., to the north branch of the Chicago River, and the other (20 ft. diameter) from the lake along 39th St. to the south branch of the river. It will also provide pumping stations of 35,000 and 40,000 cu. ft. capacity to keep up a current of water through the sewers and the river into the drainage canal. The maintenance of the sewers and pumping plant will be undertaken by the drainage board. The city engineer has been directed to prepare the necessary plans for these works.

THE REGULATION OF THE RIVER TIBER, in Rome, says Alexander Batocchi, Inspector General du Genie Civil, was commenced in 1877, and of the estimated cost $21,000,000, $14,600,000 has been expended. The work involved consists of the enlargement of the river section to a uniform width of 100 m., or 328 ft., at low water level; the building of stone training walls over a total length of 8,313 m., of which 7,440 m. are built; the construction of levees, faced with stone, above and below Rome; in the deepening of the channel at many places, and the building of intercepting sewers on the right and left banks of the Tiber within Rome. These sewers have a total length of 33,076 m. Four new bridges are also to be constructed over the river. The floods of last winter proved the efficiency of the work already done. The water gage at Orte, 73 miles above Rome, showed an average flood height nearly 7 ft. lower than for any previous year of record.

THE PANAMA CANAL SCANDAL is on again in Paris in the form of the trial of members of the Chamber of Deputies accused of receiving from 6,000 to 100,000 francs each for their influence. At the first day of the trial Emile Artcn, agent and lobbyist for the Panama Canal people, testified that he disbursed 2,000,000 francs in all to Deputies. This Arton was extradited from England about two years ago; and being sentenced to two years' imprisonment he appealed from his sentence and promised to explain completely the distribution of the sum mentioned.

A LARGE AMOUNT OF IRRIGATION WORK IN UTAH is said to be assured through the recent contract between the State and the Lake Bonneville Water & Power Co. The company agrees to reclaim 216,000 acres of land in Millard Co., presumably under the Carey act. It will also develop electric power for use in the Tintic mining districts. Mr. Morton B. Hirsch is President of the company.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred Dec. 20 on the Pennsylvania R. R. at Altoona, Pa. Owing to the slippery condition of the track a 31-car freight train became unmanageable and coasted some 12 miles down the heavy grade west of Altoona, crashing into a freight train standing in the yard directly in front of the passenger station. Three employees were killed and three others injured.

AN EXPLOSION OF AN ACETYLENE GAS LIGHTING plant in Wilmington, Del., Dec. 16, killed one person. According to reports this plant, which had been placed in the Federal building by agents of the Electro Gas Co. of New York city, had not been turned over to the authorities, and the engineer and elevator operator of the building were in the habit of charging the generator with the calcium carbide. At the time of the explosion it is supposed that the elevator attendant was putting the carbide in the hopper of the machine previous to opening a valve which allowed the material to come into contact with the water of the generator.

A FIRE AT LAFAYETTE COLLEGE, Easton, Pa., on the morning of Dec. 18, destroyed one of its fine buildings, known as Pardee Hall. Aside from the loss of the building a large amount of apparatus belonging to the department of civil engineering, the Ward library containing some 10,000 volumes of valuable books and a valuable collection of minerals and birds were lost.

THE CAUSE OF THE BOILER EXPLOSION that took place at the Graves Elevator Works, Rochester, N. Y., on Nov. 22, has been investigated by the chief inspector of the Hartford Steam Boiler Inspection & Insurance Co. It appears that the boiler was an ordinary horizontal tubular boiler, 66 ins. diameter, 16 ft. long, made of ⅝-in. steel plates. It was only four years old. Mr. J. M. Allen, president of the Hartford S. B. I. & I. Co., says, concerning the cause of the explosion:

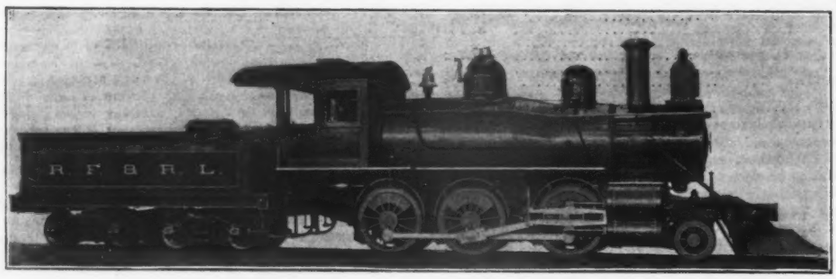
> Our chief inspector has made a careful examination, and has satisfied himself that it resulted from one of those incipient cracks that are hidden in the joints by the overlap of the sheet. We have found several similar cases. The cracks are so located that they cannot be discovered by an inspection, as from an internal inspection the inner lap does not show any fracture whatever, and the outer lap covers the fracture which has not worked through the plate. As to the cause of this kind of fracture, we have pretty well satisfied ourselves that it comes from an effort to bring the plates together at the edges after they have been rolled; that is, the outer lap sometimes "cocks up" a little above the lower plate, and is brought into place by hammering. We are led to arrive at this conclusion from the fact that, in visiting boiler works, we have seen this kind of practice, and have protested against it, as it is very liable to start an incipient fracture which, under the conditions of use and pressure, is liable to develop into a dangerous weakness. There seems to be no other well-founded reason for such a weakness being developed. The holes are punched in the plate and considerable metal is taken out, and then the effort to bring the lap of the plate together would be liable to bring a pretty severe stress at the points where the plate is forcibly bent.

A COMPRESSION TEST OF CAST-IRON COLUMNS was conducted by the Department of Buildings of New York city, at Phoenixville, Pa., beginning Dec. 15. Four round columns 15 ft. long and 15 ins. in diameter were crushed after the large testing machine, owned by the Phoenix Iron Co. (Eng. News, Jan. 10, 1891), had been compared with the Watertown machine. The tests were under the direction of Mr. W. W. Ewing, of the Department of Buildings. A full account will be published in a later issue.

A RE-RATING OF WARSHIPS, by displacement instead of by armament, is proposed by Secretary of the Navy Long. The present law is out of date and divides naval vessels into four classes, rated by the number of guns carried. The new law, which Congress will be asked to pass, will place all war-ships of 5,000 tons or more displacement in the 1st class; all of 3,000 to 5,000 will be 2d class; all of 1,000 to 3,000 tons will be in the 3d class, and all under 1,000 tons will be 4th rate, except torpedo boats and torpedo boat destroyers and submarine vessels. These latter will form a special class. Under this classification we would have 17 1st rates, 16 2d rates, 39 3d rates and 18 4th rates, including in the last navy tugs.

TWO RECENT FREIGHT LOCOMOTIVES.

We illustrate herewith two freight locomotives recently built by the Baldwin Locomotive Works, which are good examples of moderate weight locomotives for railways of light traffic. The locomotive shown in Fig. 1 is a standard gage Mogul on the Vauclain compound system. It was built for the Rumford Falls & Rangeley Lake R. R., in Maine, and has been doing excellent work since it has been put in service there. It will be noticed that the usual arrangement of the cylinders is reversed, the high-pressure cylinder being placed underneath. The boiler is designed for a working pressure of 180 lbs., and is built of ⅜-in. and 11-16-in. steel with all longitudinal seams butt-jointed with double cover strips sextuple riveted.



VAUCLAIN COMPOUND FREIGHT LOCOMOTIVE FOR THE RUMFORD FALLS AND RANGELEY LAKE R. R.
The Baldwin Locomotive Works, Philadelphia, Pa., Builders.

The American outside equalized brake is applied to both driving and tender wheels.

The locomotive shown in Fig. 2 is a narrow-gage ten-wheel engine built for the Western R. R., of Guatemala. It is notable for the placing of the firebox between the two rear pairs of driving wheels. This brings these wheels so far apart that the coupling rod which connects them is made of the old-fashioned fish-belly pattern, to secure sufficient transverse strength. This locomotive is equipped with the Westinghouse American outside equalized air brake on driving and tender wheels, and has a valve on the line of the lower gagecock for holding the train on the Le Chatelier system. The boiler pressure is 160 lbs. and the plates are 9-16-in. thick, with butt-joints and double cover strips.

The principal dimensions of the two locomotives are summarized in the following table:

	R. F. & R. L. R. R.	Western R. R. of Guatemala.
Gage	4 ft. 8½ ins.	3 ft.
Cylinders, h. p.	14 × 24 ins.	16 × 20 ins.
" l. p.	24 × 24 "	.....
Drivers, diameter	57 ins.	46 ins.
Total wheel base	20 ft. 6 ins.	21 ft. 8 ins.
Driving wheel base	12 " 6 "	12 "11 "
Weight, total	129,200 lbs.	76,300 lbs.
Weight on drivers	109,200 "	57,200 "
Boiler, diameter	60 ins.	54 ins.
Number of tubes	280	190
Diameter of tubes	2 ins.	2 ins.
Length of tubes	11 ft.	10 ft. 6 ins.
Firebox, length	89⅝ ins.	50 ins.
" width	33⅜ "	40 "
Heating surface, firebox	136.5 sq.ft.	.....
" " tubes	1,600 "	.....
" " total	1,736.5 "	.....
Truck wheels, diameter	30¼ ins.	24 ins.
Truck journals	5 × 10 ins.	4 × 6½ ins.
Driving axle journals	8 × 8½"	6½ × 7 "
Tender capacity	3,200 galls.	2,500 galls.
Tender wheels, diameter	33 ins.	26 ins.

REPORT OF THE NEW YORK STATE RAILROAD COMMISSION ON THE GARRISONS DISASTER.

The full report of the investigation of the Board of Railroad Commissioners into the cause of the accident which occurred near Garrisons, N. Y., on the New York Central & Hudson River R. R., on the morning of Oct. 24, leaves the matter almost as much in doubt as ever. Stated in their own words, the final conclusions of the Commissioners are: "That this train was wrecked either by derailment, which destroyed the embankment, or that the embankment gave way and threw the train into the river." Inconclusive as this conclusion of the Commissioners is, their investigations have served to bring out considerable valuable information regarding the construction of the track and roadbed at the point where the accident occurred. This information we abstract from the printed report as follows:

Construction of Roadbed and Track.

The break in the embankment was in the form of a semi-ellipse, or half-pear shaped, with the greatest curve or indentation in the northerly third of its length, and tapering off at the south end toward the sea wall. The westerly or outside ends of the ties on the displaced track had been about 15 ft. from the water edge of the wall, but the cleavage of the roadbed had, at its deepest transverse point of indentation, swept away not only this margin of surface, but the whole of the southbound track, ties and everything, and cut off the embankment itself with a vertical face fracture, up to within about 4 ft. 6 ins. of the tie-ends on the easterly or northbound track. The northerly and southerly ends of the gap in the bank sloped at angles of about 40° to 60°. The vertical face of the fracture above indicated was about 30 ft. in length and extended sheer downward to and below the level of the river water, which had flowed into the breach. At the time when the train was dislodged the tide was low but rising, and to this, in some degree, may be attributed the fact that no lives were lost in the sleepers, and that so many persons were rescued from the coaches in which fatalities did occur.

The embankment was originally constructed in or about the year 1849. Its foundation was broken rock and stones, covered with gravel, sand and earth. This was topped off with substantial stone ballast. A slight bench was made in the rocky hillside or bank east of the roadbed, there being short rock cuts about 500 ft. south of and 300 yds. north of the scene of the break. The alinement of the tracks for all of these distances referred to was practically straight, so that little, if any, outward or centrifugal thrust was exerted by passing trains. On the river side of the embankment was a dry wall of stone about 3½ ft. to 4 ft. thick and 8 ft. in height, resting on a rip-rap foundation, and intended to protect the toe and natural slope of the bank from displacement or disturbance by water or ice from the river. The space between the inner face of the wall and the shoulder of the embankment, and extending to about the level of the crown of the bank was filled in with earth, gravel and cinders. It was, as already stated, about 15 ft. across and was unoccupied by tracks. The whole body of the embankment, as revealed by the face of the fracture, was well impacted, the line of fracture being as distinct as if the cleavage which formed its vertical face had been made through homogeneous rock. On the land side of the roadbed, directly across the tracks from the point in the break where this vertical face appears, is a rock slope covered with earth and vegetation, and down the face of which runs a small crooked gully, carrying a stream of water. This stream flows from the orchard on top of the hill into a small natural basin alongside of the roadbed, and is fed by springs and varies much in volume, according to the condition of the weather. About the date of the accident its volume of water was very small. A ditch running southward 250 ft. to a small cove was intended to drain the basin, but this ditch was not always effective, and a residuum of water remained in the basin. It is quite likely that any water lodging in the basin and not evaporated or carried off by the ditch, gradually seeped into the earth alongside of and beneath the embankment. The embankment was about 35 ft. broad from its eastern shoulder to the westerly edge or face of the dry wall, which does not appear to have been built for or engaged as a retaining wall, except so far as it retained the light earth and cinder filling behind it. The wall had been newly topped up for three or four feet of its height about a year ago.

The tracks were laid with first quality steel rails, 100 lbs. to the yard, resting on yellow pine ties, 2 ft. apart at centers, the rails spiked to each tie and fastened at the joints with six-bolt angle bars. The joints were what is known as three-tie joints, with the "Harvey" pattern of nuts and bolts, the nuts on the outside surfaces of the rails.

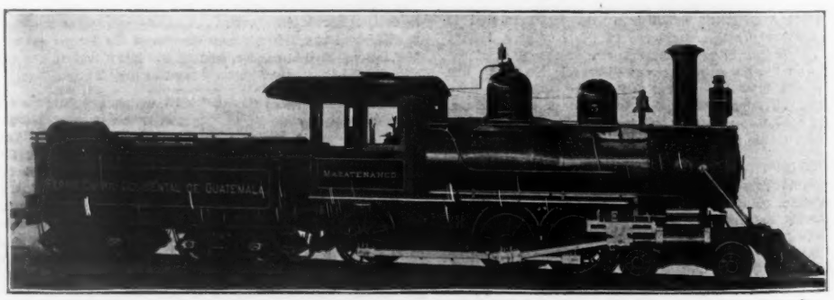
Causes of the Accident.

The condition of the track, embankment and roadbed; the testimony of the expert civil engineer witnesses and the evidence given by railway officers and operatives, suggest several possible but no positive or probable causes for the accident. The possible causes are: (1) The sliding out of the embankment from the bottom, in consequence of saturation from the gully, or from the wash of the river along the base of the sea-wall, or both. (2) The sagging of the southbound track (in consequence of the erosion of the embankment by tidal action through the interstices in the sea-wall) to such an extent as to cause the train to leave the track. (3) The derailment of the engine or some of the leading cars: (a) by accident or by wilful obstruction; (b) by a broken rail, wheel, or portion of the gear or mechanism of the engine or cars; (c) through an undiscoverable cause, such as sometimes occurs in cases of derailment.

The evidence falls altogether short of proof that the embankment went out with a slide from the bottom. The borings made in cross-section on the embankment and extending out for 75 ft. in the river showed that there is a shelving or inclined bottom, varying much in its angle of depression at different points, but averaging say 40° or 45°. The borings were all carried down to bed-rock, the natural overlying strata being, first, mud and silt and next blue clay of varying thicknesses resting on the bed-rock. Along the line of the break there was found no evidence that the overlying soil or clay had been displaced, or had given way outward from the line of the wall. On the other hand, there is strong proof that the lower courses or foundation of the wall, resting on the rip-rap base, are still in situ. At one of the exceptionally low conditions of the tide, according to the testimony of De Graw, the foot of the wall was visible, in place, for the whole length of the gap in the bank. The testimony of the engineers in charge of the survey and of the diver who was examined before the Board, tends to support this statement.

As to the second possible cause, the fact that some saturation of the bank resulted from the gully stream is established, but no one of the experts will express the opinion that this saturation was the cause of the accident, or that it had operated to such an extent as to "weaken the bank sufficiently to make it dangerous."

Professor Wm. H. Burr stated that in his borings on that precise line he found no important evidence of saturation nor any evidence of weakening. On the contrary, he found the easterly part of the bank and roadbed, which had not been displaced at all, very firm, and he cited the fact that the passage of heavy trains for some three days after the accident over this narrow intact portion of the roadbed and close by the vertical face of the fracture which still stood firm, as proof of the rigidity of the structure even after its front support was torn violently away. Indeed, that embankment stood vertically for over a month after the accident, no repairs having been made to it beyond throwing into the gap some limbs of trees, loose earth and small stones to prevent the rise and fall of the tide from cutting in beneath it. Mr. John Bogart concurred in Prof. Burr's opinion, but Mr. T. C. Leutze, Assistant State Engineer, inclined to the belief that the embankment was weakened by the action of the



NARROW GAGE FREIGHT LOCOMOTIVE FOR THE WESTERN R. R. OF GUATEMALA.
The Baldwin Locomotive Works, Philadelphia, Pa., Builders.

water from the gully, though he declined to say that he believed it to be so deteriorated as to cause or induce the dislodgment of the train. The next consideration is, whether the westerly front of the embankment, along the lower face of the wall, had been disintegrated by river water—tidal action. As the whole upper two-thirds or three-fourths of the wall and the bank behind it had disappeared into the river, nothing conclusive could be ascertained in that direction. The only fact which might bear affirmatively upon such a theory is that such erosive action was possible and that the rise and fall of the tide, having at this point an extreme variation of over 4 ft., against a dry-wall face and in front of a sharp incline toward the river bottom, might have such a tendency. Examinations of the wall in the immediate vicinity and where substantially similar conditions exist, failed to disclose serious erosive displacement. It is proper also to note the fact that less than an hour before this train was wrecked, train No. 28, carrying eleven heavy cars, including four loaded baggage cars and moving at a rate of 35 to 40 miles an hour, had passed, southbound, in safety over this identical track. The train was heavier, by probably 25%, than No. 46, the wrecked train. It may be reasonably asked why did not the embankment (if it was weak) give way under this heavier train rather than under a lighter train an hour later, in which interval of time it is scarcely likely that any important erosive change could have taken place? And it is equally fair to inquire: Did not the heavier train (if there actually was any erosive weakening), perhaps, produce in its passage the final shock of detrition which prepared the bank for collapse under the next succeeding impact? Conjectural inquiry and reasoning of this character will serve to illustrate the extreme difficulty which the Commission has encountered in dealing with this subject, in the absence of specific demonstration as to actual conditions.

Looking next at the question of a derailment being the possible, or probable, cause of the fracture and displacement of the embankment, the case is full of conjecture and incertitude. All of the cars which went into the river lost their trucks, but these were all recovered through the work of divers and derricks. The engine carried all of its wheels into the river, but the tender left its forward truck of four wheels and a single pair of wheels from its rear truck on the embankment. The wheels and trucks were found at considerable distances apart and in a great variety of positions on the river bottom. Not a wheel or axle belonging to any vehicle in the train was broken. The throttle valve of the engine was closed when it was taken from the river, but the reversing lever was in the "running notch," and the lever controlling the air brake showed that the brakes had not been applied from the engine. Apparently, therefore, the train was running freely and the engineer had not seen or anticipated any danger whatever. The throttle lever was bent, however, as though a blow had struck it and probably closed the valve.

The only mark or scar found on any wheel is a bruise or dent about 1½ ins. in length, ¾-in. broad in its broadest part and not more than ⅛-in. deep in its deepest part, on the outer margin of the tread of the right hand forward wheel of the engine truck. There is no mark whatever on or within 2 ins. of the flange of this wheel. Two sections of rail-ends, which had been joined together by angle bars but had been broken apart, were also brought before the Board. But consideration of the scar on the wheel and the defacements of the rail, the bolts and angle bars as a whole, and as evidence of derailment of the engine is without avail, for the reason that the wheel was a right-hand wheel while the rails are left-hand rails.

A feature of the accident which may have some significance is the manner in which the engine appears to have acted. The engine did not go into the river at the gap in the bank, but either rolled, was dragged, or was hurled off the embankment some 25 or 30 ft. south of the southerly extremity of the gap. In going over the embankment it crushed and broke down the surface of the dry-wall, smashing in twain some of the large stones and grinding others, but the wall was not driven out into the river or wholly beaten down. Its upper part was simply wrecked on its own foundation. Fragments of the cab of the engine, of the engine step and of the iron flag socket on the left-hand side of the pilot, were found on the bank and indicated conclusively where the engine had gone overboard. The truck and pair of wheels belonging to the tender lay amid the wreckage of stone and roadbed near by, on the sloping ruin of the embankment. The right side of the center casting on the tender truck was broken away and the bolt or pin was wrenched off in the cup of the casting, indicating a heavy lurching twist of the tank. The engine and tender were found by the diver lying almost side by side, about 75 ft. distant from the sea-wall in 50 ft. of water. The engine lay on its right side, with the pilot pointing toward the wall and northeasterly, its rear furthest out in the river. Its position shows that it must have been almost completely "slewed" around, as it was heading south before it left the track; this, however, may have been due to slipping on the mud and clay of the sloping river bottom, for the engine was almost buried in the mud when the diver located it. The engine was most defaced and scraped on its left side, and the pilot frame on that side was slightly bent upward; some of the slats were broken out.

General Manager Toucey testified that he saw deep furrows in the surface of the embankment, between the southbound track and the edge of the wall, which he believed to have been made by the engine on its course from the track to the edge of the embankment. This disturbed and plowed-up condition of the bank was observed also by one of the Commissioners and the stenographer of the Board. The first three cars in the train appear to have overshot the engine after it plunged into the water.

These assembled but rather incongruous facts are substantially all that can have any bearing upon the question of a derailment, unless, perhaps, the injuries inflicted upon the cars themselves may be added. All of the cars were vestibuled, and the vestibules and ends of the first six cars in the train were practically demolished by collision or impact with each other. In some cases this demolition extended for as much as 8 or 9 ft. into the framework and body of the car—a complete crushing and splintering. It was noticeable that the greatest injury and shock appeared to have been sustained by the most forward cars and that the extent of damage, by crushing and breaking, diminished successively on all the cars toward the rear.

The Board has given exhaustive consideration to every fact and theory presented or obtainable, in a conscientious effort to ascertain and declare officially the cause of the disaster, especially with a view to guarding against the occurrence of like catastrophes. As to the roadbed and tracks it is not reasonable to conclude that they were at fault. The theory of a slide or "slip-out" from the bottom is fairly shown to be untenable. If it be assumed that the foundation of the roadbed was weak, the evidence fails to establish affirmatively such a condition. On the contrary, the basic structure was composed of excellent material, properly placed, and had endured for nearly fifty years. Civil Engineer Bogart gives it as his opinion that such an embankment, with reasonable care and maintenance, has no period of what may be called "life;" that it undergoes no form of deterioration or decomposition, except that of displacement; that it grows more impact and rigid by use, particularly by the jarring of train movements, and that it should endure definitely. No evidences of displacement or weakness were discovered by him or by Professor Burr, which could be presumed, in their opinions, to have caused or contributed in any degree to the dislodgement of the train. This is practically and substantially the view taken by other expert witnesses on this phase of the case, and the Commission feels itself required to adopt a similar conclusion, for there is no affirmative proof to the contrary. Any other judgment would be predicated chiefly upon theory and surmise.

In like manner the testimony fails to establish affirmatively a derailment of the train, or any part of it, as the factor in the driving out and breaking down of the embankment and roadbed. The scars on the tire of the engine wheel and those on the rail do not concur. Therefore, they have no relation to each other. If there was any obstruction on the track, it was not observed by the engineer in time to enable him to check the speed of the train; neither was there any obstruction discovered; nor do any of the trainmen say that they felt any application of the air brakes, or any whistle or indication of alarm from the engineer. If there was a derailment either from sagging of the roadbed, from obstruction on the rails or track, or from some of the unknown and undiscoverable causes which at times do lead to derailments, it must have been at about the deepest part of the gap in the embankment, and all evidences of its character or exact location was swept with the material into the river. And even then it is scarcely conceivable that the derailment originated under the engine, for were it so, the engine would almost certainly have been directly involved and gone down into the excavation created by the shock. The engine was probably three or four times heavier than any other vehicle in the train, and it is improbable that after its impact had broken the embankment, it would have gone a hundred feet or more further, plowing as it did into the bank, and rolling off the wall, without demolishing the embankment itself as was actually done where the gap opened. If a derailment was the actual cause, it probably originated or occurred under the first, second or third car, at a point over which the engine and tender had passed and the engine and tender may then have been dragged from the rails by the weight of the train, which "buckling" outward toward the river and acting like a wedge driven in a transverse direction, forced out the embankment. Such a "buckling" transverse movement may have been the cause of the "swaying" motion so precisely described by Conductor Parrish, terminating in the shock which threw him directly across the day coach, from left to right. It is noteworthy fact also that no one of the cars carried into the river turned over, whether in shallow or deep water. The day coach, however, which was in deep water, settled heavily by the head or forward part, and seemed for a time to swing on that end as on a pivot.

THE STATUS OF WORK ON THE CHICAGO DRAINAGE CANAL.

At the meeting of the Board of Trustees of the Sanitary District of Chicago, on Dec. 15, the new president, Mr. William Boldenwick, presented his first message to the Trustees, in which he reviewed the progress of the work, and outlined the important works yet to be executed. The following is an abstract of the message:

With the earnest support of your honorable body we can at least keep pace with the past and thereby have the great work intrusted to us completed and the waters of Lake Michigan flowing through our channel by the fall of 1899. Predictions have previously been made for earlier completion, but when one considers the magnitude of this enterprise and the continuous obstacles to be overcome, the time thus far consumed sinks into insignificance.

The Sanitary District has expended up to the present time $25,287,689, and has to show for it 6,919 acres of land, being property acquired between Robey St. and the city of Joliet for right of way; excavating 27,086,431 cu. yds. of glacial dirt and 12,256,029 cu. yds. of solid rock; building 372,949 cu. yds. of stone and concrete retaining wall, and a portion of the bridges, being about 87% of the cost of the entire channel, from Lake Michigan to Hickory Creek, at Joliet, a distance of 40.6 miles; or of the main channel proper 28.5 miles in length, of which 97.21% is now done, including the river diversion, and having occupied up to the present time five years. This, I am convinced, compares favorably as regards both time and expenditures, with other works enumerated below:

Name.	Lengths in miles.	Years bldg.	Total rock and earth.	Cost.
Suez	66	9	80,000,000	$100,000,000
Corinth	3.7	12	15,220,000	15,000,000
North Holland	16	11	21,000,000	15,000,000
North Sea	61.5	8	.....	37,440,000
Chicago	40.6	5	40,000,000	25,300,000
Manchester	35.5	6	53,500,000	77,000,000

The criticism expressed by the local press, and the impatience demonstrated from time to time by the residents of the District for the speedy completion of the work, is caused rather by the fear of sickness and epidemic consequent on the pollution of Lake Michigan by the waters of the Chicago River. It is for this reason I consider it my duty at this time to make public some of the causes of delay.

The first board of trustees was elected in December, 1889, and held its first meeting on Jan. 18, 1890, elected its officers, and proceeded forthwith to have surveys made and plans prepared for carrying out that for which it was elected. Up to December, 1891, however, or nearly two years after the first board of trustees was elected, practically nothing had been done which could be considered an advancement of the work. During the fall of 1891, three of the trustees resigned, and others were elected to fill their places, and the board was reorganized. The first step taken by the new board was the consideration of the route laid out by the former board. Railway officials, contractors and experts were invited before the board, and upon mature deliberation and investigation it was ascertained that the route previously decided upon was too expensive, and almost impracticable, the damages for railroad property alone being estimated at $12,000,000, and excavation, which was mostly in rock and under water, would have cost at least three times as much as the route now located and adopted. This investigation consumed several months, and directly after the trustees decided that the new route be selected, the chief engineer was ordered to make new surveys and plans. Ordinances were passed locating the new channel as follows:

From Willow Springs to Joliet, March 27, 1892; from Willow Springs to Summit, Aug. 10, 1892; from Summit to Ashland Ave., Nov. 9, 1892. Immediately after the passage of the first ordinance real estate experts were employed by the board to appraise the value of lands, and negotiations for the purchase of the same were begun. Lands were acquired and contracts let so that on Sept. 3, 1892, the first shovel of earth and rock was excavated by the then president, Hon. Frank Wenter. From this time on work has progressed as steadily and as fast as circumstances and our means would permit.

At the beginning of the enterprise the financial condition of the Sanitary District was approximately as follows:

Cash on hand	$361,417
One-half of 1% on assessed valuation for 3 yrs.	3,705,000
Five per cent. on assessed valuation for issue of bonds	12,350,000
Total	$16,416,417

Purchasing of land and awarding of contracts were so vigorously pushed that by the spring of 1895 the trustees were compelled to go before the legislature and ask for additional aid. The request had to be repeated in 1897, and was again granted. The law creating the Sanitary District allows us to raise money by the issue of bonds to the amount of 5% on the assessed valuation of property in the district, but not to exceed $15,000,000. Owing to the continued decrease in the assessed valuation of property in the Sanitary District, we were deprived of $3,000,000 in bonds. The assessed valuation in 1891 was $254,011,212; in 1896 it was $241,324,219, and now it is but $229,500,000. At the last session of the legislature another condition was placed upon the Sanitary District, which not alone caused a great delay but an additional expenditure of several hundreds of thousands of dollars, viz.: the substitution of swinging for fixed bridges. Agreements and contracts had been entered into between the Sanitary District and the railway companies whose rights of way were crossed for fixed bridges. New negotiations had to be entered into for swing bridges, some of which are closed while

others are still pending. Aside from these obstacles, a number of contractors, finding they had contracted too low and were losing on their contracts, and others failing to comply with their contracts, either forfeited them themselves or waited until the board declared them forfeited, necessitating readvertising and reletting, and entailing a loss of much valuable time.

In spite of all these obstacles and delays which were unavoidable this great work has progressed as fast as any other similar work. There yet remains to be done about 13% of the entire work necessary to complete our main channel. This includes the work through Joliet and the deepening and widening of the Chicago River.

The press and public have an erroneous impression as to the powers of the Sanitary District in deepening and widening the Chicago River in order to maintain a continuous flow of at least 600,000 cu. ft. of water per minute and to accommodate a ship drawing 22 ft. of water. In the first place the powers of the District are not sufficient to raise the millions necessary to pay for the property to be taken for the widening of the river, the cost of strengthening foundations fronting on the same, and the lowering of the tunnels. This would all have to be accomplished before any great amount of excavation could be undertaken. The necessary plans for the required flow in order to enable us to open our channel when completed, viz., 300,000 cu. ft. per minute, have been under way for some time. Land has been purchased and contracts let for deepening and widening the Chicago River, and I am confident that by the time our main channel is completed the Chicago River will be in condition to provide the water required by law, and also not interfere with navigation.

By the agreement entered into between the Sanitary District and the city of Chicago the city is to construct a 20-ft. conduit at 39th St., to connect with the east arm of the South Branch and erect a pumping plant, and also to construct a 16-ft. conduit at or near Lawrence Ave., and erect a pumping plant, in order thoroughly to flush each end of the river. The Sanitary District is forever to maintain these two pumping plants. This was a very wise and equitable solution of this question, as it releases the District of all outlay save maintenance, the gross amount of which could not at this time have been taken away from the main channel or raised under our present assessed valuation.

These conduits, more especially the one at the South Branch, will, after filling up the west arm of the South Branch (which, in my opinion, should be done by the officials of the city of Chicago, as I am informed that it is not a part of the Chicago River, but private property, and had been excavated by brick manufacturers), thoroughly cleanse this portion of the river. But this will not be sufficient for the North Branch of the Chicago River for all future time. The North Branch receives the drainage from an area of 172 square miles, and the sewage of 500,000 people, and at the present and the greater part of the year the flow in it is so shallow that one can wade across from shore to shore from Belmont Ave. north.

The ultimate solution of the problem of the purification and protection of the North Side water supply will demand a more and comprehensive treatment. This treatment may reasonably be upon the line of the extension of the Chicago River northward at least as far as the city limits, and connected by an open cut with Lake Michigan, where a pumping plant of capacity sufficient to maintain a flow northward of at least 150,000 cu. ft. per minute should be established. This open channel would become available for navigation by constructing a lock through which vessels could be raised from the level of the lake to the higher level in the channel. Such treatment would meet all of the requirements of sanitary dilution and give to the territory through which the channel would pass the advantages which are incident to navigation, thus accomplishing by one expenditure of money a double mission of public benefit.

Now, I must remind you of what remains to be done.

Starting with the Chicago River, in addition to the dredging which is now in progress, there is the building of the by-passes between Adams and Van Buren Sts., and from Taylor St. south to a point below the Chicago & Northern Pacific R. R. bridge. The river must be widened to carry out the plans which we have adopted. Docks must be built to replace those which we destroy in carrying out our plans.

Sections N, O, E, and F must be completed. The right of way of the railways which still form barriers across our channel must be removed. Seven highway bridges must be built and one eight-track and six double-track railway bridges. The bear-trap dam must be completed. The tail-race along the route finally adopted must be constructed. The stretch of channel between the end of the tail-race and the head of the upper basin at Joliet must be built. The work between the upper basin and Hickory Creek through Joliet, including the canal lock and the weir and water-power dam must be built, and the changes in bridges, street grades and sewers in Joliet must be perfected.

In a word, work not now under contract, aggregating, according to the chief engineer's estimates, $3,756,485, must be put under contract.

The work outlined is essential to the successful carrying out of the purposes for which the district was organized and no part of it can be dispensed with, therefore it behooves us to make sure of its accomplishments beyond the possibility of doubt before venturing upon works of an auxiliary character, no matter how meritorious those works may be. From the showing before us it appears that we will pass the threshold of 1899 with a deficit of $2,500,632.80, but that within that year there will be available as assets $3,350,000, or a seeming surplus of $849,367.20; but it must be borne in mind that obligations will mature early in 1900, which will make heavy inroads upon this balance. In that year we must return to first principles and work within the limits of a revenue based upon one-half of 1% of the assessed valuation of the district, and that fact must be borne in mind in all of our plans for future work.

Another matter for your early consideration is the annexation or bringing into the Sanitary District of the following towns or parts of towns, in order to make the District include all of the territory within the jurisdiction of the city of Chicago: Two on the north known as Rogers Park district and the Norwood Park district, and the third and lrager, the Calumet district, on the south. The Rogers Park district consists of the territory south of the Evanston city limits to West Devon St., North Kedzie Ave. on the west to Lake Michigan, containing four square miles; the Norwood Park district being the territory bounded substantially between Hamilton St. on the north and West Bryn Mawr Ave. on the south and Winter St. on the west to Austin Ave., and containing about 2¼ sq. miles. The Calumet district extends substantially from 87th St. to 136th St. and Western Ave. to the Illinois and Indiana state line, containing about 45 sq. miles.

These towns will eventually receive the benefits of our main channel as future work may be necessary within their boundaries, and we would not be justified in expending any money for auxiliary work therein unless they were part of the Sanitary District. It is true that a portion of these towns was annexed after the Sanitary District was laid out by the commissioners, but it is also true that they should not expect the benefits of this great undertaking without sharing their just proportion of the cost. The time is not far distant when the town and city of Evanston will be compelled to make provision to come into our fold or to ask the privilege of draining into our channel at the north, and such requests should be granted upon receiving a proper compensation for moneys expended.

DOUBLE TRACK ELECTRIC RAILWAY VIADUCT FOR ST. LOUIS & SUBURBAN RY., AT EDGEBROOK, MO.

(With two-page plate.)

The increasing demand for bridges and trestles designed expressly for electric railway traffic, which has resulted from the rapid extension of electric trolley lines into the suburban and rural districts, has been mentioned at various times in the past issues of Engineering News, and attention has been called to the opportunities which the construction of these and other permanent way structures for electric lines seem to offer to the experience of that large class of engineers which the present decrease in railway building has compelled to seek other employment. In the purely urban construction of electric railways there are few bridge structures designed solely for the railway traffic, and consequently little is found regarding such structures in the records of recent engineering experience, but as such lines were extended into the suburban and country districts, bridges, viaducts and trestles designed solely for electric cars were demanded, and within the last two years many instructive examples of such structures have become available for study. In the issues of this journal for Jan. 9 and April 16, 1896, illustrations and descriptions of two standard trestle designs for electric railways were given. In this issue the record is continued by illustrating and describing a more pretentious steel structure recently erected at Edgebrook Station, about 8 miles from St. Louis, Mo.

The Edgebrook bridge is located on the St. Louis & Meramec Ry., which is a western extension of the St. Louis & Suburban Ry. Co.'s electric trolley lines to the suburban towns of Webster and Kirkwood, and is about eight miles from the St. Louis Union Station. It is a double track steel viaduct, 900 ft. long over all, and crosses the tracks of the Missouri Pacific Ry., and the valley of the River Des Peres. Fig. 1 shows an elevation, plan and numerous cross sections of the structure. From the elevation and plan it will be seen that the structure consists of five 36-ft., six 45-ft., and six 30-ft. plate girder spans, and one through and one deck truss spans 135 ft. long, each, all carried on steel trestle bent towers. Only three lengths of plate girders, it will be noted, are used in all of the 17 plate girder spans, and similar conditions of uniformity in the dimensions of tower and trestle bent members are observed upon a study of the drawings.

The material used throughout the bridge is soft steel of the quality required by Cooper's highway bridge specifications for 1890, and the workmanship, details of construction, inspection, painting and erection were required to conform to the same specifications, with the following alterations:

Web plates of girders shall be not less than 5-16-in. thick; no material in the structure shall be less than 5-16-in. thick and the cover plates of the top chords shall be not less than ⅜-in. thick. No rods shall be used of less area than 1 in. square.

Although using steel, the unit strains specified were those prescribed in Cooper's specifications of 1890 for iron, no additional allowance being made for steel. The loads for which these strains were calculated were: (1) A dead load of 350 lbs. per lin. ft. for each track to provide for the weight of the floor; (2) the dead load of the entire weight of the steel work; (3) a live load of 1,000 lbs. per lin. ft. of each track and a concentrated load of 24,000 lbs. on one axle. The specifications also stated that:

The maximum strains due to all positions of the above live load and the dead load shall be used to proportion the parts of the structure. Wind strains and vibrations must be provided for by proportioning the top laterals in deck spans and the bottom laterals in through spans for a load of 300 lbs. per lin. ft., all considered as moving load. The bottom laterals of deck spans and the top laterals of through spans shall be proportioned for a moving load of 150 lbs. per lin. ft. The transverse bracing and columns of the trestle towers shall be proportioned to resist, in addition the strains produced by dead and live loads, the strains due to a transverse wind force of 400 lbs. per lin. ft. of the structure, applied at the level of the base of the rail. The longitudinal bracing of the trestle towers shall be sufficient to resist the strains caused by an assumed longitudinal force applied at the top of each trestle post of 250 lbs. per lin. ft. on each track. The longitudinal bracing shall be proportioned with the unit stresses allowed for wind stresses.

To show how these requirements worked out, the accompanying table (Table I.) has been compiled for the floor beams, stringers and other plate girder work, and the strains in the various other members incorporated in the drawings of Fig. 1.

The track system consists of T-rails laid on 8 × 8-in. oak cross ties sized to 7½ ins. over stringers and spaced 8 ins. apart in the clear. Every fourth tie is bolted to the stringer by ⅝-in. hook bolts, and the rails are spiked to the ties. Outside of each track rail is a 6 × 6-in. guard rail laid flat and notched 1 in. over the ties, and fastened to every third tie and at each splice by ⅝-in. hook bolts. These guard timbers are of long leaf yellow pine, and both they and the oak ties were subjected to careful inspection. This description applies to one track only, but the other track was exactly the same in construction. Between the two inner guard rails is placed a 2-in. plank walk, which, with unimportant details, completes the track structure.

With this previous review of the general struc-

TABLE I.—Showing Strains in and Composition of Plate Girders, Floor Beams and Stringers in Edgebrook Bridge.

Character of member.	Depth		Pounds per sq. in. Chord strain.	Shear.	Composition of chords.	Composition of webs.	Area, in sq. ins. Chords.	Web.
Girders:	ft.	ins.						
36-ft. spans: Center girder..	3	8	93,000	36,700	(2) 6×4 in. × 14.7 lb. angles.	44x5-16 ins.	8.64	13.75
Outer girders	3	8	86,000	33,900	(2) 6×4 " 13.5 " "	44x5-16 "	2.94	13.75
45-ft. spans: Center girder..	3	8	134,300	42,200	(2) 6×4 " 21.0 " "	44x5-16 "	12.4	13.75
Outer girders	3	8	124,800	39,300	(2) 6×4 " 19.5 " "	44x5-16 "	11.5	13.75
30-ft. spans: Center girder..	3	8	69,800	33,100	(2) 5×3½ " 11.0 " "	44x5-16 "	6.5	13.75
Outer girders	3	8	64,200	30,400	(2) 5×3½ " 11.0 " "	44x5-16 "	6.5	13.75
Floor beams: Through span....	3	9	101,600	58,500	(2) 6×4 " 16.0 " "	45x5-16 "	9.4	14.06
Deck span	2	8	68,900	20,300	(2) 5×3½ " 11.0 " "	32x5-16 "	6.5	10.0
Stringers: Through span	2	6	69,300	28,700	(2) 5×3½ " 11.0 " "	30x5-16 "	6.5	9.38
Deck span	Same as for through span given above.							
Transverse bent girders:								
Nos. 1, 2, and 5 to 18.....	3	8	71,100	29,300	(2) 5×3½ " 11.5 " "	44x5-16 "	6.76	13.75
No. 3	4	2	110,400	71,100	(2) 6×4 " 17.0 " "	50x5-16 "	10.0	15.62
No. 4	5	4	112,400	124,400	(2) 6×4 " 17.5 " "	64x⅝ "	10.3	24.06

Note.—Dead loads used were: For 30-ft. spans, 1,120 lbs. per lin. ft.; for 36-ft. spans, 1,180 lbs. per lin. ft.; for 45-ft. spans, 1,270 lbs. per lin. ft.; for 135-ft. spans, 1,550 lbs. per lin. ft. Outer girders carry 31.86% of total load, and center girder, 30.28% of total load. Live load, 1,000 lbs. per lin. ft. per track, and 24,000 lbs. concentrated wheel load.

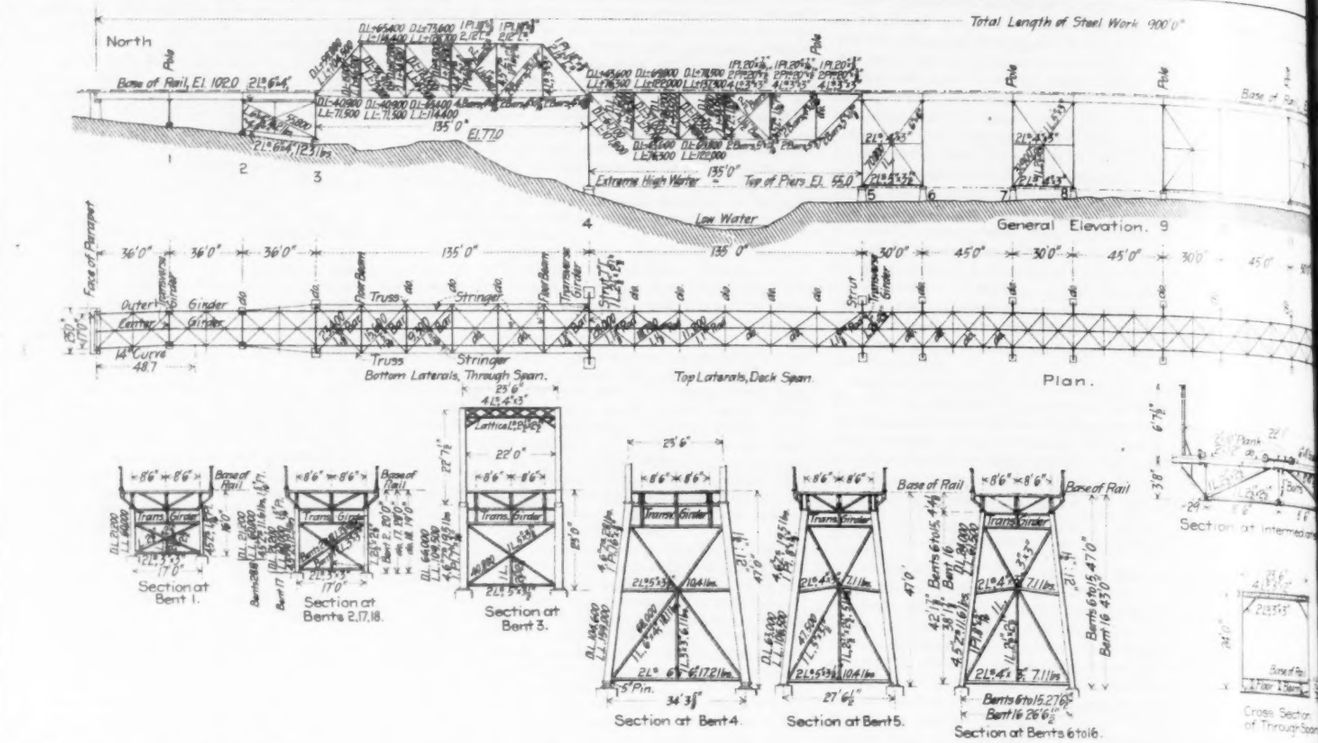


FIG. 1. GENERAL PLAN AND ELEVATION AND SE

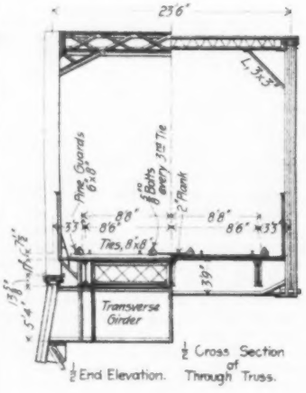


FIG. 8. SECTIONAL ELEVATION AT BENT NO. 4.

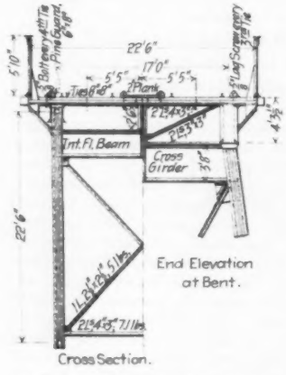


FIG. 10. SECTIONAL ELEVATION AT BENT NO. 5.

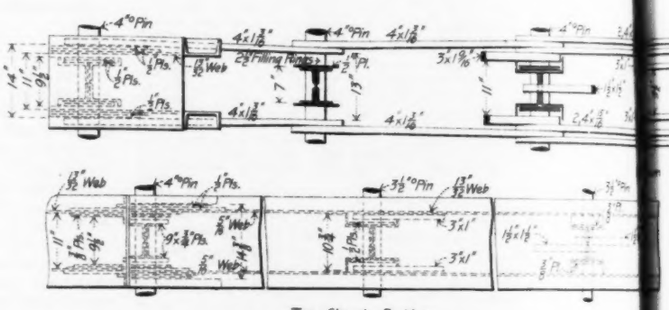


FIG. 6. DETAILS OF CHORD PACKING FOR THROUGH TRUSS.

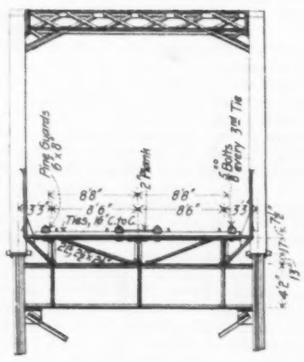


FIG. 9. SECTIONAL ELEVATION AT BENT NO. 3.

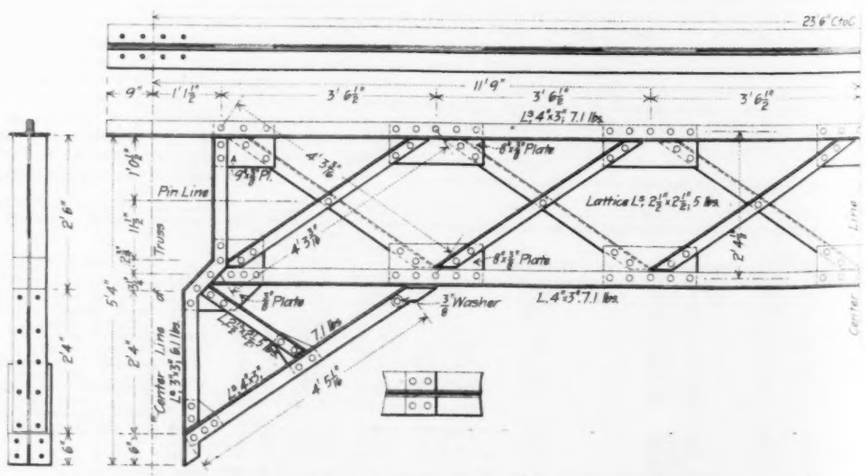
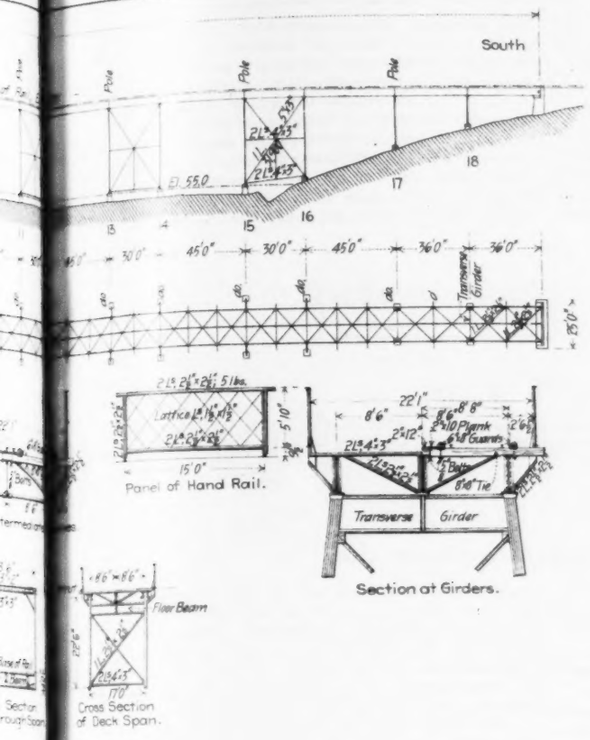
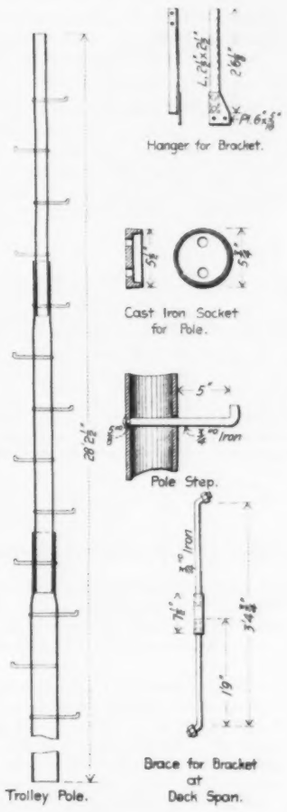


FIG. 11 DETAILS OF PORTAL BRACING FOR THROUGH SPAN.





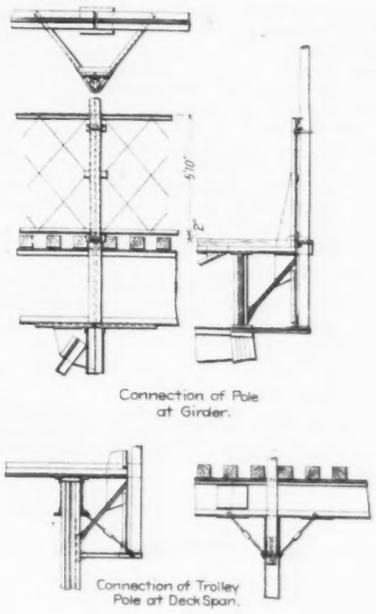
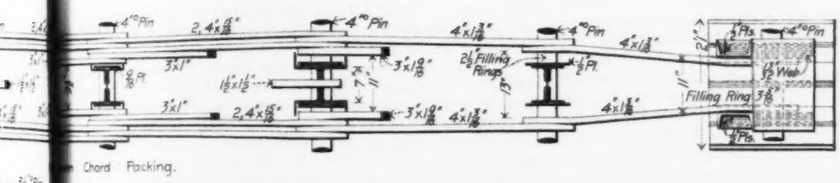
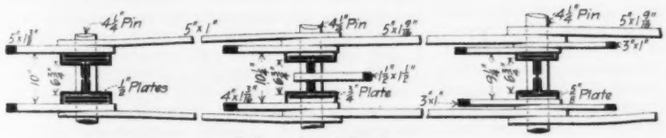


FIG. 12. DETAILS OF TROLLEY WIRE POLES AND CONNECTIONS.

ND SECTIONS.





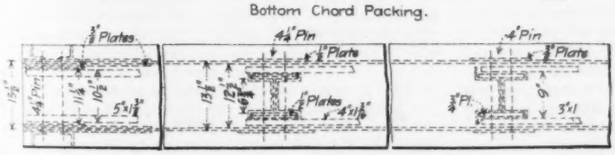


FIG. 7. DETAILS OF CHORD PACKING FOR DECK TRUSS.

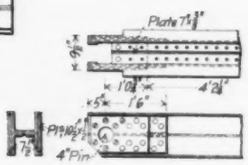


FIG. 3. DETAIL OF TOPS OF LEGS FOR BENT NO. 3.

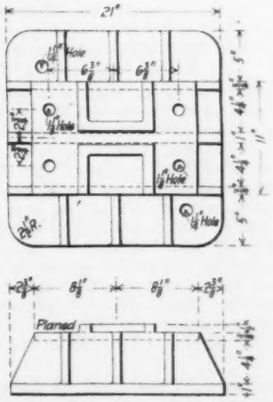


FIG. 5. CAST BASES FOR LEGS OF BENTS NOS. 6 TO 16.

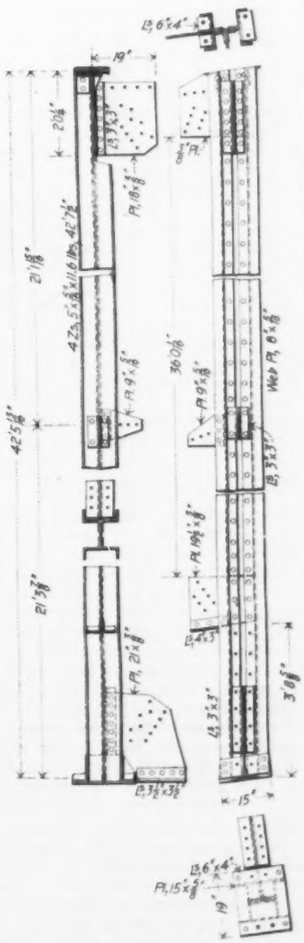


FIG. 4. DETAILS OF LEGS AND CONNECTIONS FOR BENTS NOS. 7 TO 14.

ELECTRIC RAILWAY VIADUCT
FOR ST. LOUIS & MERAMEC RY.,
EDGEBROOK, MO.

J. B. Chase, President, St. Louis & Meramec Ry.
Detroit Bridge & Iron Works, Detroit, Mich.,
Contractors and Designers.

CHAS. HART & SONS, LITH., 88 VESEY ST., N. Y.

tural features and requirements, attention may be turned to the more important individual parts. For convenience these will be considered under the heads of towers, plate girder spans, truss spans, floor system, and minor constructions.

Practically only seven of the structures supporting the spans can be called towers, that is, two bents braced together laterally and transversely; the others being slight bents. The composition, strains and dimensions of each member of all of these towers and bents are shown by the several drawings of Fig. 1. The bents to be noticed particularly are Nos. 3, 4 and 5, which carry the truss spans. The legs for bent No. 4 are shown in detail by Fig. 2, in which are to be noticed the pier and pedestal bearing on the cast base plate and the pin connections for the truss spans at the top. Bent No. 3 also has the pin top connection shown by Fig. 3, but all the other bents have, in general design, the top and bottom construction shown by Fig. 4. Except bent No. 4 all bents are fastened rigidly to the foundation by cast bases of the design shown by Fig. 5, and in bent No. 4 the pin-bearing pedestal is attached to a base similar to that shown by Fig. 5, but larger. Here it needs to be stated that the dimensions on Figs. 4 and 5 are correct only for the bents designated in the captions, but that the general type of construction is correct for all the bents in the bridge, although, of course, modifications are made necessary in bents Nos. 1, 2, 3, 17 and 18, in which the legs are vertical instead of being battered at the rate of 1½ ins. in 1 ft. The nature of these variations are so easily comprehended that it has not been thought necessary to illustrate each in detail. For information regarding the composition and character of the sway bracing, and the transverse girders bracing the bents together, Fig. 1 and Table I. may be consulted.

The plate girder deck spans consist of three lines of plate girders 5 ft. 6 ins. apart c. to c., and made up as shown by Table I. Fig. 1 shows the style and composition of the sway bracing holding the girders together. It will be understood from Fig. 4 that the girders are riveted direct to the cap plates of the tower legs.

Turning now to the two truss spans it will be seen that Fig. 1 gives the general dimensions and the composition of the chord and web members, and the lateral bracing. Figs. 6 and 7 show the chord packing for the through and deck spans, respectively, and Figs. 8, 9 and 10 show the character of the end connections at bents Nos. 3, 4 and 5, where the only irregularities in the plate girder span end connections are found. These truss spans have, of course, plate girder floor beams at the panel points and girder stringers under each line of rail, and the composition of these members are given in Fig. 1 and Table I. As will be seen, there is nothing unusual in this floor construction, and it needs no further description. Fig. 11 shows details of the portal bracing for the through span.

The remaining metal work of the bridge consists of the handrail, trolley wire poles and connections and minor details. Fig. 1 shows the character and composition of the handrail, and the various drawings of Fig. 12 the line poles and their connections. The piers and abutments were of Portland cement concrete. Bids were received for the work Feb. 6, 1896, the contract signed Feb. 15, and the bridge completed ready for traffic May 25, 100 days from the date of the contract. The contractors were the Detroit Bridge & Iron Works, of Detroit, Mich., and the designing was done by the engineers of that company under specifications prepared by the R. E. McMath Surveying Co., of St. Louis, Mo.

THE LAKE ERIE AND OHIO RIVER SHIP CANAL.

The report of the provisional committee of the Pittsburg Chamber of Commerce, upon the proposed Lake Erie and Ohio Ship Canal, is now published in an octavo volume of 269 pages, with maps and photographic views. This report is an exhaustive one, commencing with the commercial demands for any canal, and discussing the route, dimensions, available water supply, feeders, traffic on the Ohio River and the canal, estimates of cost, etc.

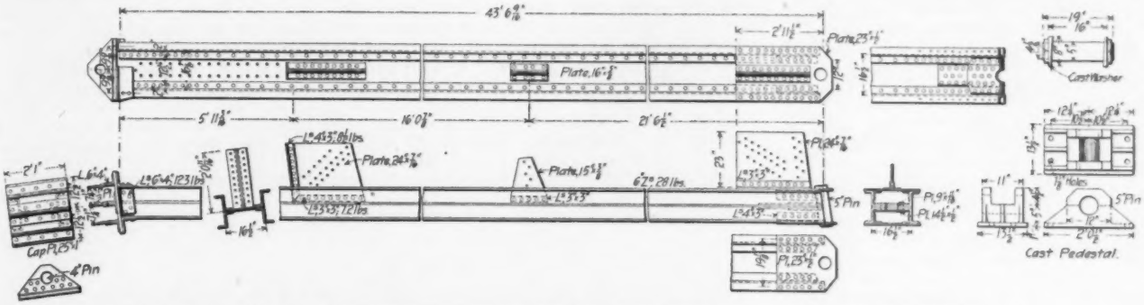


FIG. 2.—DETAILS OF LEGS AND CONNECTIONS FOR BENT No. 4, ELECTRIC RAILWAY VIADUCT, EDGEBROOK, MO.

As arguments for the building of the canal the board of consulting engineers brings forward the following facts: The population of the Pittsburg district, within a radius of 60 miles, was 1,608,000 in 1890, and is now at least 10% greater. This region is a vast consumer of products transported on the Great Lakes; and the commerce of these lakes, for 1889, is figured as aggregating 22.6% of the total transportation business of the railways of the United States for that year. The board finds that the present annual traffic over the railway "portage," between Lake Erie and the Ohio River, amounts to about 18,500,000 tons; including 7,000,000 tons of iron ore, 7,000,000 tons of coal, 2,000,000 tons of coke, 1,000,000 tons of heavy manufactured products, and 1,500,000 tons of limestone, lumber and general merchandise. The board, therefore, concludes that 13,000,000 tons, as the probable annual tonnage over a much cheaper water route, would be a safe basis for estimating revenue from the canal on completion. The present cost of bringing ore from Lake Superior to Ashtabula is put down at $0.80 per ton; from Ashtabula to Pittsburg, including transfer and dockage charges, the cost is now $1.15; making a total cost at Pittsburg of $1.95. The estimated cost by canal, over the last division of the route, is $0.13 per ton; and if to this is added the old canal toll of the Pittsburg & Erie Canal, or $0.25 per ton, the total cost would be $0.38 per ton. The saving between the rail and the canal routes would thus be the difference between $1.15 and $0.38, or $0.77 per ton. In the same manner the tariff on coal would be reduced from the present charge of $1.05 to $0.33 per ton; and coal could be delivered at Chicago for $1.67, at Duluth for $1.50, and at New York for $1.75 per ton.

By applying these economies to the existing traffic, and omitting the inevitable increase resulting from reduced cost, the board figures out a total reduction in the price of coke, coal and iron, for the regions effected, equalling $10,778,687 per annum. At 25, 15 and 20 cts. per ton, respectively, the canal would earn, in the transport of these few items alone, about $3,169,049, or 9.6% on $33,000,000. And for the six principal lake cities a further economy of nearly $12,000,000 is calculated in the coal supply alone, making a total annual economy resulting from the building of the canal equal to more than half the estimated cost of the canal; and this from only three main items of traffic.

The route proposed by the board of engineers follows the Ohio River, 23.36 miles, from the Davis Island dam, to the slackwater of the Beaver River; thence up the Beaver and Mahoning River, by a slackwater system of pools and dams, 42.26 miles to Niles; thence 31.35 miles across the summit, and the canal would descend the 572.86 ft. to Lake Erie in 12.55 miles. The total distance from the slackwater on the Beaver to Lake Erie, at Ashtabula, is only 98.9 miles, with a lockage of 526 ft. From Pittsburg harbor to Lake Erie the distance is 122.16 miles, with a total lockage of 548 ft. The shortest air line between the Ohio River and Lake Erie is 84.3 miles long.

As to the topography of the region to be traversed, the elevation of the summit level is only 900 ft. above tide, while many points in the possible available drainage district touch 2,000 ft. or more. The plan includes a lake or reservoir, 8 miles long, on the summit level of 31.35 miles; and as this summit plain is flanked by high ranges of hills, the board believes that there is an abundance of water to meet all further demands of commerce.

For reasons fully given, a minimum depth of 15 ft. is assumed as sufficient for the needs of the canal; the lock dimensions suggested are 340 ft. long between quoins, 45 ft. wide and 15 ft. deep on mitre-sill; the estimate of water consumption, for 48 lockages, or 24 vessels each way daily, is 22,000,000 cu. ft. plus 18,000,000 cu. ft. for evaporation, filtration and leakage, or 40,000,000 cu. ft. daily; a minimum clear headway of 45 ft. is deemed necessary for the class of vessels likely to use the canal; the canal cross-section recommended is—depth 15.5 ft., bottom width 102 ft., and top width of 156.25 ft.

The area depended upon to furnish water to the summit level covers about 1,074 sq. miles. It is proposed to draw from the stream flow of this area about one-half the estimated amount falling upon it between Nov. 1 and May 1, the season of greatest precipitation and least evaporation, and thus leave the summer flow undiminished. The water thus taken would be stored and delivered to the canal as needed in the season of navigation, estimated at 225 days in the year. The board based its investigation upon the lowest recorded rainfall of the region affected, or 22.8 ins. at Oil City in 1888, while the average of that station for 14 years was 40 ins. Between Nov. 1, 1887, and May 1, 1888, the rainfall at this point was 15.22 ins.; of this it was assumed from data covering similar drainage areas, that 70%, or 10.65 ins., passed off in stream flow. Taking less than half this amount, or 5 ins., as drawn off into the storage reservoirs, there would be furnished for canal use 11,314 million cu. ft. of water; while on the basis of a lock consumption of 40,000,000 cu. ft. per day, the quantity actually required would only be 9,189 million cu. ft. The flow from this area, and without resort to any of the other readily accessible basins, would thus, says the board, provide for at least an annual traffic of 16,000,000 tons; and as the summit level will probably receive water from the drainage of adjacent flat lands, rather than lose by filtration, this estimate might be safely increased to 20,000,000 tons per annum.

Three feeder lines are considered, and the board congratulates the commission on the fact that the natural supply of water, including the feeder connections, conforms so well to the needs of the canal. The question of bridges over the canal is an important one, as the region traversed forms part of the broad belt through which passes much of the enormous railway travel and freight traffic between the East and the West. As a consequence, the line of the canal would be crossed by 80 bridges, 21 of which are for railways. The

minimum clear headway adopted is 45 ft.; but on 18 highway and 9 railway bridges draw spans are unavoidable.

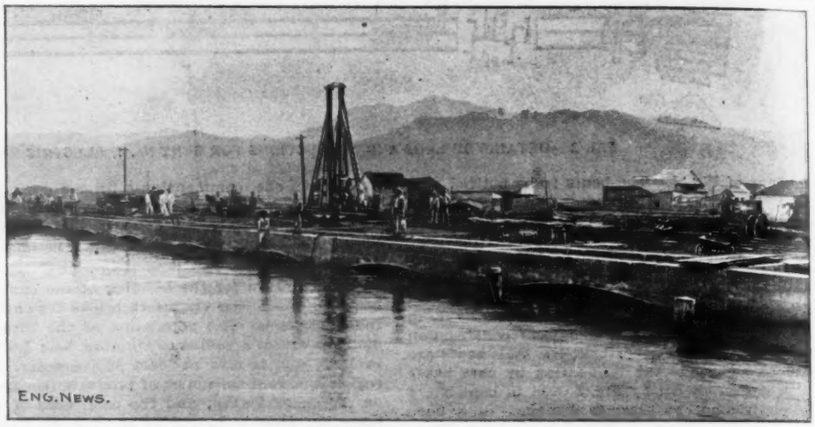
The summary of estimates of cost is given, somewhat condensed, as follows for the several parts of this extensive work:

Ohio River Division:	
Davis Island Dam to New Brighton, 23.26 miles.	
Earth, at $0.20 per cu. yd.	$1,221,120
Rock, at $1.00 per cu. yd.	114,440
Concrete wall, at $5.00	5,003,300
5 locks (excavation included above)	718,633
Culverts	225,000
Bridges: 1 railway; 7 highway	170,886
Right of way; 350 acres, and damages	550,000
Electric light plant	46,000
Total	$8,139,379
Beaver River and Mahoning River Divisions:	
New Brighton, Pa., to Niles, O., 46.26 miles.	
Excavation and dredging	$4,531,360
11 locks	1,639,179
Dams; stone filled	508,000
Bridges: 12 railway, 21 highway	1,119,183
Right of way; 1,620 acres	202,500
Electric light plant	92,540
Total	$8,092,762
Mosquito Creek, Summit and Lake Erie Divisions:	
Niles, O., to Ashtabula, O., 52.64 miles.	
Excavation, canal prism	$3,792,045
Excavation for levels and locks	4,736,310
Puddling	15,000
22 locks	3,596,373
Dams	127,793
Bank protection	1,015,896
Culverts	328,650
Electric light plant	105,260
Total	$10,689,242
Feeder; Bemus Dam, Pa., to Canal at Jefferson, O.: Length, 55.62 miles.	
Eastern Division, 32.32 miles:	
Excavation, at $0.18	$551,668
Bemus Dam	14,722
Culvert	159,810
Masonry, guard gates, etc.	1,500
Pymatuning reservoirs	736,578
E. & P. R. R. crossing	34,550
Embankment, at $0.20	59,550
Masonry and guard gates, Sect. D	1,620
Bridges: 12 highway, 2 railway	38,300
Right of way	174,185
Total	$1,772,483
Western Division, 23.30 miles:	
Excavation	$279,393
Tunnel, brick lined	738,395
Mill Creek reservoirs	92,687
Masonry and guard gates	4,500
Bridges: 9 highway	22,500
Right of way	15,100
Total	$1,152,575
Auxiliary Reservoirs, etc.:	
Mill Creek reservoirs	$89,255
Feeder connection with canal	12,000
Right of way	7,400
Total	$108,655
Final Summary:	
Ohio River Division	$8,139,379
Beaver and Mahoning Rivers	8,092,762
Mosquito Creek and Summit to Lake Erie	10,689,242
Feeders, reservoirs, etc.	3,033,713
	$29,955,096
10% for contingencies	2,995,509
Grand total	$32,950,605

To the above report of the engineering board, made up of Col. Henry L. Abbot, Corps of Engineers, U. S. A., Lewis M. Haupt, M. Am. Soc. C. E., and N. H. Hutton, Engineer of the Baltimore Harbor Board, other valuable committee reports are added. The history of the growth of commerce, between Lake Erie and the Ohio River, is fully given, together with a history of the present effort to build a ship canal to connect these points. The canal is described by divisions and the committee on railway and canal statistics make a very useful and detailed report, some of the chief items of which have been already here noted. It should be said, however, that the engineering board estimates the cost of maintenance and operation of the ship canal at $250,000 per annum. As the estimated annual earnings on the canal are $3,169,049, on ore, coke and coal alone, this operating cost is only 8% of these earnings; with other items of revenue added the committee believes that there should be 10% net profit annually on the cost of building the canal. A voluminous appendix deals with the engineering details, the surveys, alternate routes examined, the size and operation of canals generally, explanation of estimates, and the detailed report of the committee on railway and canal statistics. This latter is exceedingly valuable in the figures here gathered together. The report is illustrated by a well-made map of the route of the proposed ship canal, and another showing the relation of the canal to the Great Lakes and the Atlantic seaboard.

THE NEW CONCRETE AND STEEL GOVERNMENT DOCKS AT PUERTO CABELLO, VENEZUELA.

We illustrate in the accompanying cut a concrete and steel dock of rather novel construction which was completed during the past summer at Puerto Cabello, a harbor on the Caribbean Sea, about 80 miles west of Caracas, Venezuela. Puerto Cabello is the second port in commercial importance and probably the first in natural and geographical advantages in the republic of Venezuela. It is situated on a peninsula, the northern extremity of which forms the wharf front where the new dock has been built. Lying to the north and east of the port are several islands connected by coral reefs, which form a natural breakwater, behind which lies what is called the inner harbor. This inner harbor is reached by traversing a bay several miles in extent and having a depth of water of from 60 to 100 ft. Owing to the natural protections the waters of the bay and harbor are always tranquil, and from this fact comes the name Puerto Cabello, or "port of hair," by which the early Spanish sailors strove in a rather fanciful way to commemorate the fact that they could anchor their vessels by a hair and have them ride safe from storm.



VIEW OF CONCRETE AND STEEL GOVERNMENT DOCK AT PUERTO CABELLO, VENEZUELA, UNDER CONSTRUCTION.
Mr. Thomas Llamozas, Caracas, Venezuela, Chief Engineer. N. A. Paquet & Co., Caracas, Venezuela, Contractors.

The construction of the new dock has proceeded with true tropical leisure; work having been begun in February, 1885, and completed in July, 1897. The extreme length of the dock is 450 m. (1,476 ft.), and it consists of a steel and concrete platform supported on steel piles. The portion of the platform intended for vessels of heavy draft is 8 m. (26.24 ft.) wide and 2 m. (6.54 ft.) above high tide, and the portion intended for vessels of light draft varies in width from 4½ m. to 6 m. (14.76 ft. to 19.68 ft.) and is 3.22 ft. above high tide.

The construction of the dock is shown in a general way by the illustration. A retaining wall was first built along the shore to hold back the sand. This wall is supported on timber piles 30 cm. (0.98 ft.) in diameter driven 6 m. (19.68 ft.) into the bottom, and is 6 m. (19.68 ft.) high, 3 m. (9.84 ft.) wide at the bottom, 75 cm. (2.46 ft.) wide at the top and is vertical on the face and battered on the back. Parallel to this wall and 2.65 m. (8.69 ft.) from its face was driven a row of steel piles 20 cm. (0.65 ft.) in diameter. The piles are spaced 7 m. (22.96 ft.) apart c. to c. A second row of piles, also spaced 7 m. apart, and 3 m. (9.84 ft.) from the first row, was next sunk. The piles in this last row are 30 cm. (0.98 ft.) in diameter. The piles in each row are connected by I-beams resting in U-shaped caps fastened to the tops of the piles, and the two rows of piles are braced together by I-beams bolted to the main I-beam stringers. All this metal work was protected before erection with a coating of magnetic oxide, then an enamel coating and finally three coats of oxide of lead paint, and after erection it was covered with an armor of Portland cement mortar.

The steel piles were composed of hollow tubes fastened together by collar joints. The bottom section carried a pointed shoe and the top section carried the U-shaped socket casting previously mentioned. The method of sinking was to connect a sufficient number of sections on shore to bring the top of the pile well above water when lowered and then to drive the pile with a pile driver, adding new sections as the pile descended. Generally the piles were driven about 13 m. (42.64 ft.) into the bottom, which consisted of decomposed shell detritus mixed with mud. After the driving was completed a diver fastened a disk 1 m. (3.28 ft.) in diameter to each pile close to the bottom and a few blows were then given the pile to settle the disk firmly on the bottom. The hollow interior of the pile was then filled with concrete, and the cement mortar casing was built around the outside. To place this casing an iron cylinder composed of sections and 80 cm. (2.62 ft.) in diameter was slipped over each pile and the annular space filled, using shovels with long handles, when the depth of water was not very great, and a sort of tongs terminating in a closed box when the depth was over 4 m. (13.12 ft.). These tongs kept the mortar away from the water and enabled it to be placed without danger of washing the cement away.

The I-beam framework of the platform was also protected by a cement mortar casing of the form shown by the illustration. For the casing under water a composition of one part cement and one part sand was used, and for that above water the composition was one part cement to two parts sand. The frame work of concrete and steel was covered with a plank floor.

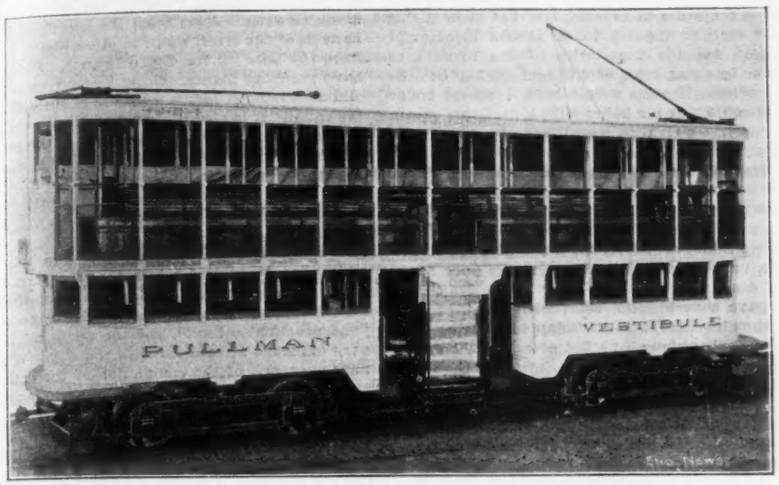
This system of concrete and steel dock construction is, it is stated, the invention of the firm of N. A. Paquet & Co., of Caracas, Venezuela, who were the contractors for the dock at Puerto Cabello. Mr. Thomas Llamozas was chief engineer of the work, which was carried out by the Venezuelan Government, at a cost of 1,900,000 bolivars, or about $1,543,000. For the information from which this description has been prepared we are indebted to Mr. S. W. Casartelli, of Caracas, Venezuela.

A DOUBLE-DECK ELECTRIC CAR OF STEEL CONSTRUCTION.

While double-deck street cars operated by horses and electricity are extensively used in Europe, they have been tried to only a limited extent in this country, even on lines of heavy traffic, where the ordinary cars afford entirely insufficient seating capacity. Although in some cases their use may be precluded by limited headway under bridges, etc., yet there are doubtless many cases where they might be introduced with advantage to the railway company and the passengers. We illustrate herewith a large double-deck electric car, built on the center-vestibule plan invented by Mr. C. L. Pullman, which is to be run on the suburban lines of the Chicago General Ry. It cannot be run into the city on account of the headway under the various railway bridges and the elevated railways.

A special feature of the design is that with the center platform, dropped low between the trucks,

the entrance is very easy, while there are no through drafts, which is a great advantage in cold weather. There are no end platforms, the ends of the car being semicircular, with the interior seats extending around the sides and ends, while at each end of the upper deck is an enclosed station for the motorman. The central platform has doors opening into the two compartments, while two stairways lead from this platform to the upper deck, which has longitudinal seats placed back to back. The upper deck is roofed over, and by means of removable sashes and partitions it can be readily enclosed so as to make it available during the winter service. At each end of the roof is a trolley pole. The car will seat 36 persons inside and 44 on the upper deck, while the total capacity, including standing room, is estimated at 200 passengers.



DOUBLE-DECK CENTER-VESTIBULE ELECTRIC CAR.

A notable feature of the construction is that the car is built of steel throughout, except that the moldings, sash frames, sash rests, etc., are of quartered oak. It was predicted that a steel car would be very noisy, but this has not been found to be the case, and the car is lighter than older cars of the same type which were built of wood. The car is 34 ft. long, and 7 ft. wide over the sills; and 35 ft. 8 ins. long and 7 ft. 11½ ins. wide over all. The height is 13 ft. 6 ins., and the car weighs about 20,000 lbs. It is mounted on two four-wheel trucks and has a Westinghouse motor of 40 HP. on each axle, but it was found that in practice two motors give ample power to run the car. The car is wired for electric push buttons inside and on the roof, so that passengers can signal the motorman when to stop without having to communicate first with the conductor.

The car was built by the Wells & French Co., of Chicago, to the order of the C. L. Pullman Car Co., also of Chicago. The latter company informs us that cars of the same type are at present in use at Saratoga and Jamestown, N. Y., but these are among the first that were built, and are of wooden construction, higher and heavier than the present car. In 1893, one or more cars of this type ran between the Columbian Exhibition and the town of Pullman, Ill.

A PROBLEM IN CONTINUOUS ROPE DRIVING.*

By Spencer Miller, M. Am. Soc. C. E.†

Much valuable literature has already been given to the engineering world on the subject of rope driving, and it is not the author's intention to review the subject generally, but merely to call attention to the perplexing problems which occur in driving with ropes, where the driving and driven sheaves are of unequal diameters, and especially where the driving wheel is the larger; as, for example, in the dynamo drive. It is acknowledged that in such drives, as usually installed, where the ropes are applied as one continuous rope with tension carriage, they will not pull equally, and, as a result, a few of them do the major part of the work, and consequently it is now recognized that a factor of safety of from 30 to 40 is necessarily employed to cover the inequality of tension, imperfections in mechanism, weakness due to grease, splice, etc.

The author is satisfied that while by the usual method of figuring a factor of safety of 30 apparently is employed, he may be able to prove that frequently the actual factor of safety is not more than 15.

In considering the problem of rope driving, it is well to bear in mind the following undisputed facts:

First.—For efficiency in rope driving, it is absolutely necessary to increase the driving power of the rope by making angular grooves in the pulleys, the common practice being to make the angle 45°.

Second.—The driving power of the rope increases rapidly as the arc of contact is increased; for example, the relative power of an arc of 120° is only 75% of that represented by 180°.

Third.—The greater the angle of incline of the grooves, the less will be the wear of the ropes; the loss of power due to the pulling out of the rope from the groove will also be reduced. This loss, however, is not appreciable.

Hence, in designing a rope drive of the character under consideration, the first thing to determine is the sharpest angle of groove permissible for efficiency and wear of rope; assume, then, that 45° is to be adopted as the minimum angle of groove, especially as this accords with the judgment of a majority of engineers.

Given, therefore, the smaller pulley with its smaller arc of contact grooved to 45°, the larger pulley may with its greater arc of contact have a greater angle of groove, without losing driving effect, and therein is a saving, for with the wider angle of groove, the rope wears less, and there is less loss of power due to the pulling of the rope out of the groove.

In a transmission of this character, if the arc of contact of small pulley is 150°, and of the large pulley 210°, and assuming a coefficient of friction of .12, the angle of the small pulley being 45°, then the proper angle for the large pulley would be about 65° for equal adhesion on both wheels.

Assuming that the ropes are uniform throughout, it is found that: By widening the groove of the larger pulley, the loss of power may be minimized and the life of the rope prolonged, at no additional expense either for sheaves or loss of driving effect.

The author's attention was originally called to the unequal tension on the ropes of a continuous rope drive some ten years ago. At that time he had occasion to study the subject, and was much puzzled by a drive installed with wooden sheaves. This particular transmission had a driving pulley of about three times the diameter of the driven, and both wheels wore badly in the grooves. The first groove wore down fully an inch; the second, ¾ in.; the third, about ½ in., and so on.

In another rope drive in the same building, also having wooden sheaves, but of equal diameter, the grooves wore alike. Hence, the natural conclusion that the unequal wear was attributable in some way to the unequal arc of contact occurring in the drive with pulleys of different diameters.

The substitution of iron sheaves for wooden ones prevents this object lesson from being brought to every one's attention, but the unequal strains on the various strands are there, just as before, and frequently can be seen if one will notice the difference in the sag of the various ropes.

As a practical proof of the value of the variable grooves, the author would refer to a rope drive designed by him some nine years ago, and installed in the planing mill of J. K. Russell, now called the Enterprise Building, on Fulton St., Chicago, where they have been transmitting 250 HP. with 12 strands of ⅞-in. ropes, which lasted six years. According to the present practice 1¼-in. rope would be employed. A 14-ft. driver is grooved to an angle of 60°, and a 6-ft. driven to 45°. The ropes may be seen to be pulling alike, and each is doing its own share of the work.

*Extracts from a paper read Dec. 15 before the American Society of Civil Engineers.

†96 Liberty St., New York city.

WORK OF THE MASSACHUSETTS TOPOGRAPHICAL SURVEY COMMISSION.

The Topographical Survey Commission of Massachusetts was established in 1884 to cooperate with the U. S. Geological Survey in making a topographical survey of Massachusetts. During the past season the general work of the commission has been the extension of the State primary triangulation system to the western line of the State and the geodetic determination of the points which mark the town boundaries.

As special work it has surveyed the boundary line between Massachusetts and Rhode Island, acting jointly with a commission from the latter State. Jointly with the State Engineer of New York they have made a partial survey of the boundary between Massachusetts and New York States. Hon. Campbell W. Adams, State Engineer of New York, and Mr. Henry B. Wood, M. Am. Soc. C. E., Chief Engineer of the Topographical Survey Commission of Massachusetts, directed the latter work. Mr. C. H. Flanigan, C. E., of Albany, and Mr. Sidney Smith, C. E., of Boston, took direct charge of the field work for their respective States.

The boundary between Massachusetts and New York States was surveyed in 1787. That commission made observations to determine the true direction of the line. They then projected a transit line over the Taconic Range of mountains, setting 18 points on the crests, running N. 15° 12' 09" E. about 50 miles. Between the transit points the line was traced with "an excellent compass." Both the transit and mile points were marked by chestnut posts and stone piles.

Subsequent surveys of towns and of private lands along this boundary have also been marked in the same manner, "stake and stones," so that it became difficult to determine the original marking. The object of the survey of 1897 was to find the position of all marks on the line, both ancient and modern. For this purpose a base line 38 miles long was selected, by erecting a signal at the north and placing a straight line, Buff & Berger transit, at the south. Intermediate points were then set with this large instrument.

This method worked very successfully. With a foresight 38 miles away, Mr. G. L. Hosmer, C. E., set eight points within a space of 6¼ ins., at a distance of 16½ miles from the large transit. Mr. W. W. Cummings, C. E., set four points within a space of 2 ins. at a distance of four miles from the transit. Messrs. Smith and Flanigan also used the large transit with equally good results.

Many details were brought out during the progress of the work which may appear in the reports to be made when the survey is completed.

The commission has been engaged for some time past in locating and straightening the boundaries of Massachusetts towns. In attempting to straighten these boundary lines the commission secures the co-operation of the authorities of the towns concerned, going over the ground with them and making and receiving suggestions. When a line is agreed upon by the State and town representatives the matter is brought up in the good old-fashioned town meeting for approval or rejection. If both of the towns interested approve the line in this way a bill is prepared and submitted to the Legislature for enactment. The passage of such a bill fixes the boundary for the future. When the work of revision and location is completed the commission will publish an atlas of town boundaries, giving all the information necessary for local use, including the description of lines and marks, and possibly half-tone views of monuments.

The commission is made up of three members, Mr. Desmond FitzGerald, M. Am. Soc. C. E., of Boston, being chairman, and the other members being Messrs. Alfred E. Burton and Frank W. Hodgdon. The portion of the above information relating to the survey of the Massachusetts and New York boundary line was furnished us by Mr. Smith. The balance was obtained from Mr. Wood, the Chief Engineer of the Survey, at the office of the commission, by a member of the staff of this journal.

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A report of two boiler tests made with the same boiler, but with different coals and different furnaces, has recently been published in a circular issued by the Hawley Down Draft Furnace Co., 39 Cortlandt St., New York. The results of the tests are themselves not remarkable, but the conclusions drawn from them in the report are, we think, deserving of comment. The trials were made on a 350-HP. National Water-tube boiler, at the rolling mills of Marshall Bros.' Tin Plate Works, in Philadelphia. In the first test a Wilkinson stoker was used with buckwheat anthracite as the fuel. This coal was of very poor quality, containing 6% moisture and giving in the boiler test 23.4% ash and refuse. In the second test, a Hawley down draft furnace was used, and the coal was Clearfield, Pa., semi-bituminous, an excellent steam coal, containing 3.96% moisture, and giving in the test only 7.56% ash and refuse. The principal results are reported as follows in the circular:

Kind of fuel	Shamokin buckwh't.	Clearfield semi-bit.
Kind of furnace	Wilkinson, stoker.	Hawley, down-draft.
Wet coal burned, lbs.	24,090	15,948
Water evap., from and at 212°..	183,790	175,834
Same per lb. dry coal, lbs.	8.12	11.48
Same per lb. combustible, lbs.	10.59	12.42
Same pr sq.ft. h't'g surf.pr hr.,lbs	3.98	3.80
Coal brnd pr sq.ft. grate pr hr.,lbs	30.4	23.8
Boiler, HP. made	444.0	424.7
Excess, capacity above rating	26.9	21.3
Temperature of stack gases, °F..	591.	548.
Saving in fuel by use of Hawley furnace	....	29.3
If 10% of steam made by boiler is used to operate stoker, then evaporation from and at 212° per lb. of dry coal is	7.31	11.48
Saving in fuel by use of Hawley furnace	....	36.3

The words "saving in fuel by the use of the Hawley furnace" are printed in the circular in large type, so as to call the reader's attention to them, and appear to us directly calculated to mislead the reader and to be quite without justification.

The saving in fuel was due rather to the use of a better fuel than to the use of a different furnace. The buckwheat anthracite, with 6% moisture, and giving 23.4% of ash and refuse in the boiler test, has only 70.6% available combustible, while the Clearfield, with 3.96% moisture and 7.56% ash and refuse, has 88.48%. A probable figure for the heating value per lb. combustible of the Shamokin buckwheat is 15,000 B. T. U., and for the Clearfield semi-bituminous, 15,800 B. T. U.; using these values and neglecting the coal contained in the ashes, gives for the available heating value of the coals: 10,590 B. T. U. for the buckwheat, and 13,980 B. T. U. for the Clearfield, showing that the Clearfield is worth 1.32 times as much as the buckwheat.

It may, perhaps, be pleaded as an excuse for the use of the expression "Saving in fuel by the use of the Hawley Furnace," that the price of these two coals is the same in Phiadelphia; but even if this is the case, it appears to us absurd to attempt to figure out the superiority of one furnace to another by using coals of different quality but the same price. If such a rule held, a steam boiler maker could test his boiler with a first-rate steam coal and test a rival boiler with the worst samples of lignite that he could find in the far West, taking care only that the freight on the latter brought up its cost to that of the good coal, and could advertise the result as the "saving due to his boiler."

The proper conclusions to be drawn from these tests, we think, are: (1) That the Wilkinson stoker gave a very fair result considering the poor quality of coal; (2) that the Hawley down draft furnace gave a very good result with the Clearfield coal, showing that it is well adapted to using that kind of coal, although no better result than it is possible to obtain with other furnaces than the Hawley; (3) that with the two coals at the same price, there will be a large saving in the use of the better coal in a furnace adapted to burn it, as compared with the use of the poorer coal, no matter how it is fired; (4) that whenever the market price of the two coals becomes approximately proportionate to their heating values then it will probably be found that the lower cost of the poorer fuel will make it quite as economical as the better fuel at the higher cost; (5) that no conclusion whatever as to the relative efficiency or the "saving in fuel" by one or other of these furnaces can be drawn, for the two furnaces are adapted to different kinds of fuel.

The Chicago drainage canal may now be said to be practically completed, over 97 per cent. of the work on the canal proper being finished, but it will be nearly two years before it can accomplish its purpose. The importance of the auxiliary works necessary for the operation of the canal is, therefore, now becoming more prominent, and some of these works will involve problems as difficult and important as any encountered in the design and execution of the whole main drainage system. The probable time for opening the canal for a flow of water from Lake Michigan is now officially given as the autumn of 1899. Earlier dates have been predicted from time to time, but Mr. Boldenweck, the new President of the Board of Trustees of the Sanitary District, in his first message to the board, calls attention to the many obstacles and delays that have been encountered, and considers that the completion of the work in 1899 will show a very reasonable rate of progress. While the first Board of Trustees was elected in December, 1889, and held its first meeting on Jan. 18, 1890, yet actual work was not commenced until Sept. 3, 1892. At the present time the board has expended $25,287,689, or about 87 per cent. of the total estimated cost of the entire channel from Lake Michigan to Hickory Creek (at Joliet), a distance of 40.6 miles, and 97.21 per cent. of the work on the main channel (including the river diversion) is now completed. From the abstract of this message, which is given in another column, it will be seen that the works yet to be executed before the canal itself is of use, are of no small magnitude. Along the canal, obstructions have to be removed and bridges built. At the western end, the bear-trap dam and regulating works have to be completed, and the tail race and channel from the tail race to and through Joliet have to be built, the latter involving extensive changes in bridges, sewers and street grades. But the most important work will be at the eastern end, in making connection with the lake, through the Chicago River. Here the drainage board will have to consider the various plans now being suggested for the improvement of the river, and will meet some opposition from those who wish the river abandoned. It will also have to consider the proposition for extending the area of the Sanitary District so as to include the entire area of the city of Chicago (including the great Calumet district on the south), and even to include Evanston and other suburban towns on the north side. The present plan is to deepen and widen the river (providing by-passes where the channel cannot be widened), and also to build two combined feeders and intercepting sewers. One of these will be along Lawrence Ave., from the lake to the North Branch of the river, and the other along 39th St., from the lake to the South Branch. Both are to have pumping plants, taking water from the lake and delivering it into a feeder to cause a flow into the canal. It is also proposed to deepen the North Branch of the river, and extend it to the city limits, and then to continue it by a canal to the lake. A pumping plant would be required to establish a flow, and it is suggested that a lock may be built to enable vessels to pass from the lock to the river by this route. This would make a very complete and comprehensive scheme, but one objection which has been set forth is that by the addition of the sewage from the various towns on the north side the sewage dilution idea would be pushed beyond practicable limits, and the result might be a very offensive stream through the city. With the near approach of the completion of the canal, the city will now also have to face the rearrangement of its sewerage system, so as to carry the flow of sewage westward, instead of eastward into the lake, as at present. This will involve considerable expense. It has been arranged that the city will build the two intercepting sewers and their pumping stations, and that the Sanitary District will then bear the expense of operating and maintaining them. With the canal affairs at their present stage, interest now centers largely upon the solution of the problem of the improvement of the Chicago River, in its relations to the port of Chicago and the drainage canal.

It is to be greatly regretted, in our opinion, that the Trustees of the Sanitary District continue entirely to ignore the possibilities of revenue to the District from the development of water power at the lower end of the canal. As we have several times pointed out the opening of the canal will create a water power at Lockport and Joliet worth many millions of dollars if it were improved. If the District were to lease the use of this power, under proper conditions, the revenue thus gained might be made to go a long way toward paying the interest on the heavy bonded debt with which the District is loaded.

We pointed out in our last issue that the most important financial question to be considered in the development of a water power is the question of securing a market for it. In the case of the Drainage Canal water power, however, the market for it is absolutely assured. The consumption of electric current in Chicago at the present day is sufficient to absorb all the power that could be developed at the Lockport end of the canal, and inasmuch as there is no other water power of any considerable amount within a radius of a hundred miles or more, a high price could be obtained for the power.

Chicago is paying millions of dollars a year for the power for pumping its water, and lighting its streets. It is groaning under the burden of the taxes which are assessed for this purpose and of the additional enormous burden in connection with the making of its sanitary canal, yet the taxpayers and those who represent them seem blind to the fact that the power which will be created when this great sanitary work is opened would light all the streets and pump all the water that the city uses.

We are aware that there are more or less legal and financial difficulties in the way of the development of the water power which the canal will create; but we know of none that are not so trivial in comparison with the great gain to the taxpayers, that they might not be readily overcome. We venture the prediction that if the works to be built at Lockport and Joliet are not so built as to facilitate the development of water power

there, a few years will see them entirely rebuilt, in such a manner that the whole of the great river which will rush down the steep slope at the south end of the canal can be put to useful work.

The announcement of State Engineer Campbell W. Adams, of New York, that the present appropriation of $9,000,000 for improving the Erie, the Oswego and the Champlain canals, will fall some $5,000,000 short of the amount required to complete the work has been so widely criticised by the newspapers, that it calls for some further notice than is given to it in the brief statement which we publish in our news columns. When the people of New York were asked to appropriate $9,000,000 for improving the state canal system, they were given to understand that this sum would be sufficient to complete the improvement which was proposed. The fact that it has not been sufficient, it is now urged by the newspapers, is reason for believing that money has been wasted. Unfortunately, there are several things which seem to give more or less color to this charge. It is pointed out with some force that, according to the State Engineer's own accounting, of the $4,263,000 which had been spent on the canal work up to Nov. 15, $88,000 had been spent in advertising and $553,000 in engineering. Both of these items, it is claimed, are excessive. It is also claimed that favored contractors have been paid enormous amounts of money in the shape of extras, which should not have been allowed. In proof of this it is shown that the twenty contracts which are completed or are nearing completion present the following peculiar features: In every instance the contract was awarded for a smaller sum than the engineers' estimate, yet everyone has cost a good deal more than the contract price, and many have cost more than the engineers' estimates. In exact figures, the ten completed contracts have cost 28.86 per cent. over the contract price, and the remaining ten, which are nearing completion, have already cost 38.65 per cent. over the contract price. A great many individual items of expenditure are presented to illustrate further this tendency toward extravagance; but enough have been given to show the evidence upon which the newspapers base their criticisms.

To the engineer there certainly seems to be need for some explanation of the vast discrepancy between the $9,000,000 originally asked for and obtained for canal improvements, and the $14,000,000 which it is now stated the work will cost. The matter which concerns our readers particularly, however, is the charge that the appropriation has been wasted since reaching the engineers' hands. Taking in order the items of expenditure in which wastefulness is charged, we have first the sum of $88,000 spent in advertising for bids for doing the work. There can be no question but that this amount is excessive. The engineers, however, had no choice in this expenditure. It is distinctly specified by the law authorizing the canal work, that each contract shall be "advertised once a week for six consecutive weeks in two newspapers in each county through which any portion of the canal passes, and in the counties of New York and Kings." That a mere fraction of $88,000 spent in advertising in a few papers having a circulation among contractors, would have secured just as efficient a competition among bidders cannot be doubted; but "practical politics" required that a sop should be thrown to the country newspapers in the shape of fat advertisements.

The expenditure of $553,000 for engineering services on work costing only $4,263,000 may seem at first sight to be exorbitant. There are, however, several reasons evident to engineers which warrant an unusual expenditure here. The work of construction has been scattered over a great length of canal, and has also been limited to the few months during the Winter when navigation is closed. This made it necessary to employ a very large corps of engineers to superintend the work. It must not be forgotten, also, that this $553,000 includes the cost of surveys, and of making plans and estimates which had to be completed before the construction could begin, and which must be charged against the entire cost of the improvement and not against a part of the cost alone.

Again, the work in deepening the canal has necessitated a very large amount of surveys and measurements in proportion to the volume excavated. The repairs to structures, etc., have generally been small work, yet they have required as much labor by the engineers as if they had been work of greater magnitude, costing a much larger amount of money. When all these things are taken into consideration, it will be seen to be a difficult matter to say what percentage of the cost of the work would be a reasonable charge for engineering expenses. This much at least can be said, however; that as far as at present appears, the "powers that be" could have no motive, political or financial, in spending money lavishly upon the engineering staff, selected by a civil service examination. If there has been extravagance in the engineering work it has probably been due to carelessness, rather than corruption on the part of those in responsible charge.

With respect to the charge that many of the contractors have been paid large amounts of money as extras, it is plain at once that the evidence presented by the newspapers shows nothing more than that in may places the work has cost more than it was estimated to cost. All who are familiar with the canal work know in a general way that much extra work has been necessary which could not be foreseen when the contracts were let. Whether in individual cases unnecessary work of this character has been done and paid for or not, only a careful investigation by competent engineers could determine. It is needless to say that no such careful examination has been made by the newspapers, and, therefore, that their opinions are at the best merely a guess at what may or may not be the truth. It seems at least fair, therefore, for engineers to reserve their judgment in this matter at least until the statement which the State Engineer is said to be preparing in explanation of this and other features of the canal work which have been criticised, has been given to the public.

THE RAPID TRANSIT SITUATION IN NEW YORK CITY.

On Friday last, Dec. 17, the Appellate Division of the Supreme Court, New York city, handed down a decision in which it approved the plan of the Rapid Transit Commission for a rapid transit railway in New York city, but in such terms and under such conditions as to render it exceedingly doubtful whether this great enterprise can ever be carried out. Briefly summarized, the opinion of the Court is that the cost of the proposed railway would probably exceed the debt limit which the Constitution fixes; and in order that this question may be passed upon by the Court of last resort, the Appellate division gives a formal approval to the enterprise. It makes the condition of even this formal approval, however, that the Rapid Transit Commission shall exact a bond of $15,000,000 from the contractor who shall undertake the construction, equipment and operation of the road. As the Rapid Transit Act itself requires the contractor to deposit $1,000,000 in cash as security for the performance of his contract, and to equip the road at his own expense, the total amount which a contracting corporation would have to put at risk would reach probably $25,000,000. Now if it should be decided that this bond of $15,000,000 must continue during the whole life of the contract, or from 35 to 50 years (a question still unsettled), the Rapid Transit enterprise has doubtless received its death-blow.

If, however, the Court should so modify its decision that this unprecedented bond will be required only for the period during which the railway will be under construction, if in addition some amelioration in the conditions and the amount of the bond is extended, and if the Court of last resort shall declare that the city can undertake the carrying out of this enterprise without exceeding its debt limit—then there is still a possibility that the proposed road may be constructed.

As most of our readers will remember, this journal has always favored the Rapid Transit enterprise. There is a general disposition at the present time to consider the Rapid Transit Ry. chiefly as a means for building up that part of New York city above the Harlem River, whereas the owners of real estate in Brooklyn and Staten Island and in the New Jersey suburbs would prefer to see the tide of homeseekers turn in their direction. But we believe that one of the most important functions of the proposed Rapid Transit system would be to give real rapid transit up and down Manhattan Island. What an anomoly it is in these days, when 60 miles an hour is a common speed for express trains, that it should require nearly half an hour to travel from the down-town office-building district to 42d St., only a little over three miles. Who can estimate the value in time saving to New York's hurrying business men which would result if one could travel at express train speed up and down that narrow central belt from the Battery to Central Park, in which most of the important business is carried on? If nothing more were done toward carrying out the Rapid Transit enterprise than to build a two-track subway for express trains only, from the Battery to 59th St., or, still better, to the Harlem River, an enormous benefit would be conferred upon the city, and the road would earn a handsome return on its cost.

To return to the present situation of the Rapid Transit enterprise, however, it must be confessed that the present outlook is far from promising. From a business point of view the investment which the city would make in the rapid transit enterprise would not be an ordinary debt at all, for the road would be almost absolutely certain to earn enough to pay the interest on its cost. From the legal point of view, however, it is probably correct to consider such an obligation on exactly the same basis as what the city spends for schools or parks, or asylums, or for the Harlem River speedway, for the benefit of millionaire owners of fast horses. And when we add to the millions which the city has borrowed to lavish on such works as that last-named, the millions of bonds which she will have to assume when she, next week, absorbs the debt-burdened municipalities on Long Island, it is by no means unlikely that the city will find itself too heavily burdened with debt to lawfully undertake the Rapid Transit enterprise.

We greatly regret the prospect that this should be the outcome of the long years of labor for Rapid Transit; and yet the situation is not without its ameliorating features. The present Rapid Transit law and the plan for construction which it lays down is far from being ideal. A measure and a method much simpler and less cumbered with red tape would be far more in the interest of the city and far less in the interest of the wealthy capitalists who under the present law are the only parties competent to undertake the construction of the road.

If the present Rapid Transit plan fails, may it not be hoped that a start will be made de novo. Many changes have occurred since the present Rapid Transit plans were prepared which deserve to be taken into consideration. We may mention for example, the substitution of the electric conduit system for horse traction on the surface railways, the approaching through transfer of passengers across the Brooklyn Bridge, the formation of the Greater New York.

These changes will have to be taken into account in any future plans. Moreover, the experience of the past seems to show that it will be necessary to give the people of New York an object lesson as to what real rapid transit is before a public opinion can be aroused in its favor strong enough to sweep away the army of trivial objectors and legal cobweb weavers who have hitherto contrived to defeat it.

Taking all these things into consideration, we venture the suggestion to the Rapid Transit Commission that if their present plan is finally defeated, they shall secure legislation authorizing the city itself to undertake the construction of a two-track subway for high speed electric trains from the Battery to 42d St., with intermediate stations, let us say, at Liberty, Chambers, 8th and 23d Sts. The cable and electric surface roads would bring passengers to these stations, and the traffic to and from the Grand Central Station alone would be of very large amount. Such a road could be built for a sum which would be a mere bagatelle for the city of New York, and there is little doubt that either the Metropolitan Traction Co. or the New York Central R. R. would be more

than willing to lease it at a rental largely in excess of the interest on its cost.

We do not pretend to say that such a road would meet the needs of the city for rapid transit; but it would be the most needed link in a future system, and its success would effectively and permanently dispose of the opposition to the rapid transit enterprise that has for so many years been successful in blocking progress. The outlying boroughs could not object to such an enterprise, for the business district of Manhattan Island which the proposed road would serve is of as vital interest to Brooklyn dwellers as it is to the residents above the Harlem. As for those who have in good faith contended that a tunnel railroad would not draw traffic, that long distance travel would not pay, that the tunnel could not be built anyway, and a long list of other objections which we cannot now enumerate, they could certainly not object to an actual trial on such a modest scale of the plan which every candid person concedes will be, if successful, so vast a benefit to the city.

LETTERS TO THE EDITOR.

Formulas for Tractive Effort in Train Acceleration Tests.

Sir: That Mr. Cooper's formula and Mr. Potter's formula (Engineering News, Dec. 9, 1897) are at bottom the same may readily be shown as follows:

From Newton's second law

$$F t = \frac{w v}{g} \qquad (1)$$

when F = force in pounds, w = weight in pounds, v = velocity in feet per second, t = time in seconds and g = the acceleration due to gravity = 32.16 feet per second per second.

But in uniformly accelerated motion from rest

$$2 l = v t \qquad (2)$$

when l is the distance in feet passed over in t seconds and v is the final velocity.

Eliminating t between (1) and (2), we have

$$F = \frac{w v^2}{2 g l} \qquad (3)$$

which is Mr. Cooper's formula.

Eliminating v between the same two equations, (1) and (2), we have

$$F = \frac{2 l w}{g t^2} \qquad (4)$$

which is Mr. Potter's formula.

Being deduced from the same two fundamental equations, (1) and (2), the formulas (3) and (4) must necessarily give the same result. T. W. Wright.

Schenectady, N. Y., Dec. 11, 1897.

Sir: I noticed in your last issue the question as to the correctness of two formulae for determining the force, or tractive effort, required to produce a given uniform acceleration. Both formulae seem to be unnecessarily complicated for the purpose in hand. Force = mass × acceleration, or f = m a, is all that is required, in which $m = \frac{w}{g}$.

Example.—A body weighing 100 lbs. moves a distance of 80 ft. in 4 secs. Required the tractive effort, assuming uniform acceleration; t = 4, w = 100, g = 32.16, acceleration $= a = \frac{v_2 - v_1}{t} = \frac{v_2}{t} = \frac{2 v}{t} = \frac{40}{4} = 10$, in which v_2 = final velocity, $v_1 = 0$ = initial, and v = mean velocity = $\frac{80}{4} = 20$ ft. per sec., $f = m a = \frac{100 \times 10}{32.16} = 31.1$ lbs.

If a weight of one ton, or 2,000 lbs = w, then $f = 31.1 \times 20 = 622$ lbs.

The above formula involves neither the square of the time, nor of the velocity. Both of the formulae employed in the discussion referred to are correct and agree with the result obtained.

The formula $f = \frac{w v_2^2}{2 g l}$ simply expresses the equality $f l = \frac{w v_2^2}{2 g}$, or work done by the force and the kinetic energy of the body, or the energy received by the body in virtue of that work. $f l = \frac{w v_2^2}{2 g} = \frac{m v_2^2}{2} = \frac{m (v_2^2 - v_1^2)}{2}$, $v_1 = 0$ in this example. Hence $f = \frac{m (v_2^2 - v_1^2)}{2 l} = m a$ where $\left(a = \frac{v_2^2 - v_1^2}{2 l} \right)$. The second formula, $f = \frac{2 l w}{t^2 g} = \frac{2 m v}{t} = \frac{m v_2}{t} = m a$. Since $a = \frac{v^2 - v_1}{t} = \frac{v^2}{t}$, $v_1 = 0$, and $2 v = v_2$; l = distance; t = time. Yours truly,

W. M. Patton.

Fireproofing Tests and the New York Building Department.

Sir: Permit me to make a correction in a statement made in your issue of Dec. 2, and also to add something to the record on fireproofing tests in this city, in justice to the parties involved. I personally originated and put into practice the modern kiln and system of testing employed, before the Building Department made any use of it. These testing grounds were established at 68th St. and Avenue A solely at the request of several manufacturers, to save time and expense, to obtain a plant safe from complaint and one reasonably convenient for the Fire Department. I am not a consulting engineer to the Department, as you remark, and I have not received, directly or indirectly, any compensation from the Department.

Mr. Stevenson Constable withdrew from the firm of Constable Bros. when appointed Superintendent of Buildings; and he receives no returns or compensation from and has no interest in said firm. The fireproofing tests were prepared by separate manufacturers, in consultation with myself. These tests were then submitted to the Department in every detail. Unless the Superintendent found them to be correctly made and developing data useful to the Department in guarding the safety of buildings, they were rejected.

The battle between competitors has been an unusually bitter one; but I believe that when the smoke of combat has drifted away all parties will acknowledge that this series of tests was fairly conducted, is the most extensive ever made in this country and that it marks a forward step in the development of fireproofing materials and construction.

I enclose a photograph of the kiln referred to, as first built; and I would remark that about five years ago, and after consultation with such men as Mr. Edward Atkinson, I became convinced that fireproofing and its tests could be reduced from a raw art to a practical science. As a general result of experience, I feel justified in making the following statement:

1. The result of 200 tests in a specially equipped laboratory, for testing the fire and water resistance of materials, was that materials labelled "fireproof" differed over 50% in relation to one another, and often greatly in materials from the same maker.

2. That the form or shape in which a material is manufactured has much to do with its success or failure in full size work. In other words, the material or form suitable for one portion of a building is not necessarily adapted to all portions or exposures. I believe that fireproofing materials should be gradually graded and rated as to use and position in a building; and that insurance companies and the community would profit by further experimental data upon this head.

3. That in testing, the fire stream should be introduced; a better distribution of heat over the ceiling should be secured; closer attention should be given to recording temperatures and a high limit of temperature should be insisted upon. The aim should be to reproduce, as nearly as possible, the conditions of an actual conflagration. In modern testing methods the heating of the entering air, the fire stream, the pyrometer, etc., have all been introduced.

The effort of modern construction should be directed towards securing a building in which the fire can be confined to the room in which it starts; and I believe we are on the right track. But there is still a wide field for improvement and development, and skillful and intelligent testing is a chief step towards this end.

Yours respectfully, Howard Constable.

New York, Dec. 13, 1897.

(In the article published in our issue of Dec. 2, to which our correspondent refers, he was spoken of as "Consulting Engineer" merely; but in such a connection that some of our readers may have formed the mistaken impression regarding Mr. Constable's relations to the Department which he corrects in the above letter.—Ed.)

Red Lead Paint as a Protection for Iron Structures.

Sir: A paper entitled "Paint Tests" appeared in your issue of Sept. 9, 1897, the force of which was weakened by too limited investigation. Since the author, Mr. Max Toltz, may be assumed to desire to deal fairly by all, this is to be regretted.

To one informed of the facts exception must be taken to Mr. Toltz's claim of the discontinuance of the use of red lead in the last ten years. This is the period of its greatest increase. A predilection for graphite paint is shown in the paper. Mr. Toltz remarks: "That these red lead men begin to add carbon black and graphite to their paint is a sign that they no longer believe red lead to be the best pigment." It transpires that the author has not included red lead in his brief laboratory tests, on which he seems to rely much more than on actual service. The results of such tests are merely suggestive, never final. Naval Constructor Francis T. Bowles, U. S. N. (Trans. Am. Soc. C. E.), says: "It is impossible to form definite, certain conclusions from any series of paint tests on plates, no matter how carefully they are made, even if they are widely distributed." This is the conviction of an expert in such work, the United States Navy experimenting most elaborately and continually.

For the benefit of Mr. Toltz, it would be well to state that recognizing the true value of carbon as a coloring matter simply and not as a pigment, the lead manufacturers themselves originally suggested its use in very minute quantities to those who would modify the vivid color of red lead. The writer has information that no railroad user of red lead employs graphite or other carbon for other purposes than a coloring matter or as a material which on account of its non-drying qualities ran of all substances be used in the least possible quantities with red lead to temporarily arrest its setting for convenience in shipping, etc.

Mr. Toltz has instituted a comparison between red lead and graphite. His analysis of the 22 samples of graphite paint which he tried showed from 17% to 95% of lime, silica, etc. No one has ever had the temerity to advocate the use of these materials by themselves. On the principle that the majority rules, the silica must be better for pigment than graphite; for it seems that Mr. Toltz showed silica and similar ingredients predominating in most of the so-called graphite paints which he analyzed.

From the diverse character of graphite paint, as shown by these tested samples, each claimed by its compounder to be better than all others, and from the fact that graphite being the lightest of all natural substances used as pigment only a modicum can be gotten into oil, "it is possible that where good results have been had with graphite paint a film of oil would have been equally efficient."—A. H. Sabin, M. Am. Soc. M. E.

There is no uncertainty about red lead. It can be relied upon in purity and performance. Its record has not been made on desultory tests, on sporadic instances of durability, nor on clever advertising. As its popularity has not come "up like the rocket," neither will it go "down like the stick." On service and history it bases its claim to confidence. "The writer has a decided preference for red lead not only because it will last longer, but because it is more uniform in good results."—G. Bouscaren, ex-Chief Engineer of the Cincinnati Southern R. R., before the Am. Soc. C. E.

The use of lead for paint and red lead for iron are from fundamental reasons of adaptability. This is proved both by the sustained practice of centuries of their use when substitutes were as freely offered as now, and by the increase in the consumption, as shown by the manufacturers' sales and consumers' records in this the present time when Mr. Toltz claims extinction of red lead. At a recent call on five of the largest bridge companies in the country, the writer was informed that for the work they then had on hand more red lead was specified than for all other materials and mixtures combined.

Ralph K. Wing.

No. 1 Broadway, New York, Dec. 13, 1897.

Notes and Queries.

Engineers are warned to be on their guard against a man who has recently obtained money on false pretenses from several well-known engineers in Cleveland, Chicago, Detroit and elsewhere. He is in possession of a check-book of a Utica, N. Y., bank, and also of a check-book belonging to Prof. C. S. Brown, of Virginia University, and his past operations have been to obtain money on these checks through false representations. He is said to be wanted in Utica for forgery. The man operates under various aliases, but a correspondent who was victimized by him describes him as follows:

The man is probably about 45 years of age, and about 5 ft. 8 ins. in height, and weighs about 170 to 180 lbs. He is thick set, carries himself erect, and has a quick, brisk walk. He has a dark complexion, dark hair streaked with grey, a very square jaw, and when in my office had a small pointed beard and mustache streaked with grey. The prominent characteristic is a mark on his forehead resembling a burn, or bruise. The mark is approximately circular, and about 1 in. in diameter. This mark seems to be a permanent characteristic, as it was noted by all those who have had the pleasure (?) of his acquaintance.

C. W. Z. writes: The Pennsylvania R. R. some time ago made several trials of using crude petroleum as fuel in their engines. Have you any report or information of the results of such trials, or where could I find a report as to whether trials were successful or not?

The most important result of the Pennsylvania R. R. tests, so far as our recollection extends, was that it was found, by a simple arithmetical computation, that if all the locomotives of the Pennsylvania system were to burn petroleum, it would require something like the total production of the United States to supply them.

There is no especial difficulty in the use of petroleum as a locomotive fuel, and it is in general use on some of the railways in Southern Russia, and in this country one or two roads in Southern California, where petroleum is cheap and coal is dear, are burning it. Under any ordinary conditions, however, the use of petroleum under steam boilers can only be of limited extent. It is a pity to use up the world's stores of this high-class fuel in such a way. Future generations, and very likely many now in active life will see the day when it will be a source of wonderment that such valuable gifts of nature as natural gas and petroleum should have been so recklessly wasted.

BREAKING TESTS OF EXPANDED METAL AND CONCRETE FIREPROOF FLOORS.

An extensive series of tests to determine the breaking strength of combined concrete and expanded metal fireproof floors was made at Long Island City, N. Y., on Dec. 16, 17 and 18. Altogether 42 separate floor arches of the construction shown by Figs. 1 and 2 were tested to destruction. The tests were made by Mr. Geo. Hill, M. Am. Soc. C. E., of New York, N. Y., for the New York Expanded Metal Co., of New York; the Manhattan Concrete Co., of New York and Boston; the Northwestern Expanded Metal Co., of Chicago, Ill.; the Central Expanded Metal Co., of Pittsburg, Pa.; the Eastern Expanded Metal Co., of Boston, Mass.; the Southern Expanded Metal Co., of Washington, D. C.; the Expanded Metal Fireproofing Co., of Chicago, Ill.; Merritt & Company, of Philadelphia, Pa.; the Atlas Cement Co., of New York; the New York & Rosendale Cement Co., of New York, and the Standard Silica Cement Co., of New York. Mr. Merrill Watson, Manager of the Central Expanded Metal Co., of New York, represented these various companies in the construction of the arches, and in all the preliminary work necessary for the tests. The tests were witnessed by engineers from the Building Departments of Boston and Philadelphia, and by a large number of architects, engineers and builders from New York and Brooklyn.

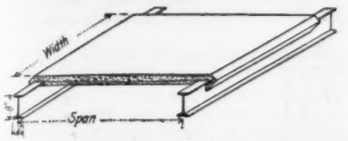


Fig. 1.—Concrete and Expanded Metal Fireproof Floor Arch Without Filler.

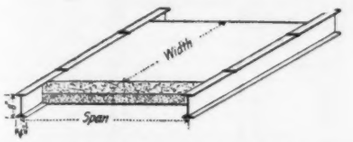


Fig. 2.—Concrete and Expanded Metal Fireproof Floor Arch with Cinder Concrete Filler.

The accompanying table shows the construction of each of the arches tested, and the maximum load and the deflection at which the break occurred. All the arches were 3½ ft. wide, and of spans of 5 ft. and 10 ft. In each case the load was applied gradually by means of a hydraulic jack to a 12 × 12-in. block resting on a 12 × 36-in. block placed parallel to the beams, or transversely across the arch at the center. The arches corresponding to Fig. 1 had no filling over them, but those corresponding to Fig. 2 had a filling over the arch composed of one part Rosendale cement, two parts sand, and ten parts steam cinders. Other variations in the construction are shown by the table.

In studying the loads under which the arches failed it must be kept in mind that each arch stood by itself entirely unconnected with the adjacent arches. Under this condition the load which the arch will bear is much less than would be the case if the arches were all connected, as they would be in actual floor construction. The ages of the arches also needs to be kept in mind. For aid in securing the information from which the accompanying table has been compiled we are indebted to Mr. Merrill Watson, Manager of the Central Expanded Metal Co., of New York, and to Mr. Geo. Hill, M. Am. Soc. C. E., under whose direction the tests were made.

THE MAKING UP OF FREIGHT TRAINS PARTIALLY EQUIPPED WITH AIR BRAKES.

By Edward Grafstrom.*

Before the advent of the air brake on freight trains it was universal practice in making up trains of both empty and loaded cars to place the loaded ones next to the engine and the empty ones in the rear. Exceptions from this rule were made only when local conditions demanded the setting off or taking up of cars at intermediate points, or when damaged cars were relegated to the rear end on account of their condition. This practice has been modified since the introduction of the air brake only so far as to place the air brake cars next to the engine, when the train is made up of both air brake and non-air-brake cars. But the relative position of empty and loaded cars has remained the same; the loaded air brake cars are placed before the empty cars, then come the loaded non-air-brake cars, and last the empty non-air-brake cars, if all four species are represented. This seems to be the prevailing custom on most railways, but whether it is the best or not is questionable.

The number of trains parting is growing at an alarming rate on many roads, and although this no doubt is primarily due to the increased tonnage of trains and a corresponding increase of strain in couplings and draft gears, yet many cases have come to light which have been ascribed to faulty handling of the train, but for which the man on the engine is perhaps not to blame as much as the practice of making up trains in the order before described. Some of the accidents from "cause unknown" could be traced to the same source, and it is also accountable for much of the costly damage done by burst air brake hose, which might otherwise have been confined to the cost of the hose. The writer has for some time been looking into the causes of trains parting, on the railway with which he is connected, and he believes that a few, at least, of these accidents could have been avoided had the trains been made up in a different order. With a view of profiting by the experience of others who may have reasoned on the same lines, he brought up the question in the "Railroad Gazette" of November 26 in a suggestion following upon an editorial on "Handling Freight Trains Partially Equipped with Air" in a previous number. But to judge from the criticism of this suggestion, verbally as well as in print, it seems as if the subject has not been given the attention it deserves by those who consider the present practice correct.

Nothing looks as smart and business-like to a practical railroad man's eye as to see a long freight train composed wholly of cars of the same class and tonnage, and fully equipped with air brakes, pull up to a stopping place and come to a standstill without a jar or a jerk, with practically no strains on the drawbars, either of compression or tension. Such occurrences are as rare, however, as the conditions under which they can take place. Although the cars in any train are moving at the same velocity while they are being propelled by the engine, the weight and the braking power of each individual car govern its retardation from the moment the steam is shut off on the engine or the brakes are applied. If all the cars have a uniform retardation, the ideal stop just described will take place. But if some of the cars have more retardation than the others, their relative velocity will soon differ sufficiently to cause tension or compression at the drawbars. The less difference there is between the retardation of adjoining cars, the less these strains will be. A non-air-brake car, retarded only by journal and rail friction, will produce more impact upon an empty air brake car than upon a loaded one, for the reason that the difference in velocity between the non-air-brake car and the empty air brake car is three times as much as it is between the non-air-brake car and the loaded air brake car.

If a train is made up of empty air brake cars in front of loaded ones, and non-air-brake cars in the rear, the latter will, when the brakes are applied, gradually give up their energy to one after another of the loaded air brake cars, while the empty air brake cars in front have begun to take up the energy of the foremost loaded air brake cars. Thus, by the time the non-air-brake cars and the loaded air brake cars have been brought to the same velocity, the latter and the empty air brake cars have also been brought to the same velocity.

If, on the contrary, the train is made up as in the present practice, with the empty air brake cars between the loaded ones and the unbraked cars, the loaded air brake cars will, when the brakes go on, jerk the first empty air brake cars forward, while next moment the unbraked cars will be brought up sharply against the rear of the empty air brake cars, which are stretched out with slack between them.

The effect of these contesting velocities was practically illustrated recently in the following manner: A freight train made up of 7 loaded air brake cars, 2 empty air brake cars, and 21 unbraked loaded cars, in the order named, was following close on a passenger train. It was a dark, foggy morning, and after having passed

*Chief Draftsman, Pittsburg, Cincinnati, Chicago & St. Louis Ry., Columbus, O.

Table Showing Construction, Dimensions and Breaking Strength of 42 Concrete and Expanded Metal Floor Arches Tested at Long Island City, N. Y., on Dec. 16, 17, and 18, 1897.

Date, built.	Span, ft.	Thickness, ins.	Concrete. Parts cement.	Parts sand.	Parts cinder.	Expanded metal, No. 10 steel. Mesh, ins.	Cross sec., sq. ins.	Maximum load, lbs.	Deflection, ins.
Arches corresponding in construction to Fig. 1.									
Nov. 16.....	5	3.87	1[1]	3	6	3	0.54	3,000	⅝
Nov. 15.....	5	3.75	1[1]	2	5	3	0.54	4,100	11-16
"	5	4	1[1]	2	5	3	0.54	5,000	1
Nov. 16.....	5	3.5	1[1]	3	6	3	0.58	3,100	1 5-16
"	5	3.5	1[1]	3	6	3	0.58	3,400	1 1-16
"	5	3.74	1[1]	2	10	3	0.58	3,600	3
Nov. 15.....	5	3.74	1[1]	2	10	3	0.54	3,000	1½
Nov. 16.....	5	3.62	1[1]	3	6	3	0.58	4,200	½
"	5	3.75	1[1]	3	6	3	0.58	4,600	½
Nov. 22.....	5	3.81	1[1]	2	7	3	0.58	6,050	⅝
"	5	4.5	1[1]	2	7	3	0.58	4,400	2
"	5	3.81	1[2]	2.4	4.8	3	0.58	4,600	2
"	5	3.75	1[2]	2.4	4.8	3	0.58	5,250	15-16
Nov. 15.....	5	3.5	1[2]	1.7	4.2	3	0.58	4,250	2¾
Nov. 17.....	5	3.5	1[2]	1.7	4.2	3	0.58	5,050	1
"	5	3.75	1[2]	3	5	3	0.58	5,950	⅝
"	5	3.5	1[2]	2.4	4	3	0.58	4,500	1½
"	5	3.81	1[2]	3	6	3	0.58	5,200	¾
"	5	4.06	1[2]	3	6	4	0.58	6,000	11-16
Nov. 16.....	5	4.06	1[2]	2.4	4.9	3	0.58	5,600	9-16
"	5	3.38	1[2]	2.4	4.9	3	0.58	4,500	15-16
"	5	3.81	1[2]	1.6	6.5	3	0.58	4,900	⅞
"	5	3.94	1[2]	1.6	6.5	3	0.58	5,700	2
Nov. 19.....	5	4	1[1]	2	5	6[4]	0.97	6,150	¾
Nov. 20.....	5	4.5	1[1]	2	5	6[4]	0.97	6,000	1 13-16
"	5	4.75	1[1]	3	6	3[5]	1.16	9,300	11-16
Nov. 20.....	5	4.19	1[1]	3	6	3[5]	1.16	9,800	1½
Nov. 17.....	5	3.87	1[1]	2.4	4.1	3	0.58	4,800	⅝
"	5	4	1[1]	2.4	4.1	3	0.58	6,500	¾
Nov. 20.....	8[7]	3.75	1[2]	1.6	4	3	0.65	2,900	½
"	10[7]	3.25	1[2]	1.6	4	3	0.65	2,150	1¼
"	10[7]	4.19	1[2]	1.6	4	3	0.64	2,000	1½
Nov. 15.....	10[7]	3.93	1[2]	2.4	4	3[5]	2.32	4,750	1½
"	10[7]	4.5	1[1]	3	5	6[4]	1.94[6]	4,250	1¾
Arches corresponding in construction to Fig. 2.									
Nov. 17.....	5	3.74—4.75[8]	1[1]	2.4	4.1	3	0.58	5,000	⅝
"	5	4.75—3.24[8]	1[1]	2.4	4.1	3	0.58	5,100	3/16
"	5	4 —3.99[8]	1[1]	3	6	3	0.58	4,850	1
Nov. 18.....	5	4 —3.99[8]	1[1]	3	6	3	0.58	3,600	⅝
"	5	4.5 —3.45[8]	1[2]	2.4	4.8	3	0.58	5,750	1
"	5	4.37—3.62[8]	1[2]	2.4	4.8	3	0.58	6,075	⅞
"	5	4.5 —3.5[8]	1[2]	1.6	4	3	0.58	5,400	1⅛
"	5	4.5 —3.5[8]	1[2]	1.6	4	3	0.58	6,200	1½

[1]Atlas Portland cement. [2]Silica cement. [4]No. 4 steel. [5]Double thickness. [6]Depth of top filler. [7]On arches of 8 ft. span and over two sheets of expanded metal have to be used to cover the span and they are therefore lapped, forming a double thickness of metal at the center.

over a slight knoll the freight train began to strike such a lively gait that the engineer became alarmed and put on the brakes a trifle harder than necessary. The coupler pulled out between the 7th and 8th car, or between the loaded and empty air brake cars, the latter retarded the first of the unbraked cars for a moment, or just enough to cause a separation, until the accumulated energy of the following cars overcame the resistance and pushed them over against the front section with the result that 8 cars were ditched. Two other recent accidents, caused by burst hose, with trains made up in similar order, have also come to the writer's notice, and it is safe to say that in either case the trains would not have parted if the empty air brake cars had been next to the engine.

The principal argument for putting the loaded cars in front of the empty ones is that the latter will not be exposed to the impact from as many loaded cars when the train is slacking up, but this argument does not hold good unless the empty air brake cars are treated as non-air-brake cars and put in the rear of the train with their brakes inoperative. To sandwich them in between loaded cars in the middle of the train can never be productive of any good results.

The Master Car Builders' Association has now a committee on "trains parting" at work, and it is to be hoped that this matter will be given due consideration by these gentlemen in the course of their researches. Besides the direct advantage of saving the rolling stock from undue strains, it would also give the engineman better control of his train, which in an emergency may mean a great deal. With the engine braked at 75%, followed by light cars braked at 70%, followed by loaded cars braked at 23%, followed by unbraked cars, the train will bunch up against the engine when the brakes go on in a more even manner and with more uniform compression of the draft springs throughout the train length, than could be possible in any other way, and the men in the cab will not feel so much surging of the train backwards and forwards before it finally comes to a stop, nor will the men in the caboose be knocked off their feet as often.

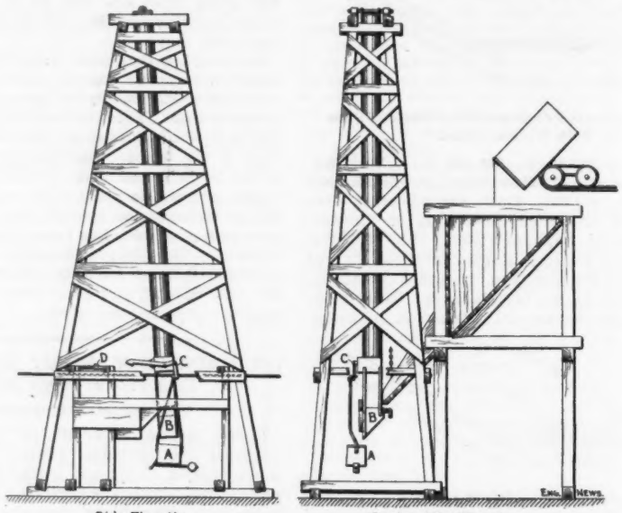
In the foregoing no reference has been made to those variations in the braking power of cars supposed to be braked with the same percentage of retarding force, which are due to the variations in the piston travel, or to the use of plain or quick-action triple valves on cars in the same train. Such variations will cause a series of light shocks, in whatever order the cars are arranged in the train. The variation in piston travel must be guarded against by the inspectors, and other inequalities are of less importance than the correct placing of the cars.

AN AUTOMATIC LOADER FOR WIRE ROPE TRAMWAYS.

We illustrate herewith a device for loading the carriers of wire trams and ropeways, which was recently patented by Mr. A. S. Hallidie, of San Francisco, Cal.

The device consists substantially of a pendulum swinging on trunnions about 16 ft. above the level of the moving cable. It is placed in front of the ore bin and receives the ore from the chute whence it is discharged into a loader box, and thence into the carrier box on the ropeway. The pendulum is made from No. 16 sheet iron tubing 12 ins. diameter. At its lower end is attached a loading box which contains, when loaded, enough ore to fill one carrier of the ropeway. The loader box has two slides, a back and a sloping bottom—the front of the box is open. With an open front the ore dumped in would, of course, slide out immediately, but while the box is being loaded it is held between a guide and a fixed partition or bulkhead. The ore is thus held in a stationary position by a hooked latch which forms part of a tripping device consisting of a lever working on a fulcrum, and will be held there until the latch is released from its keeper.

The releasing of the loading box is done by the clip on the moving ropeway cable to which the ore carrier is suspended, and which, as it moves along, strikes the end of the lever and raises the latch. At the time the loading box is released the ore carrier is immediately under the nose of the loading box ready to receive the contents of the box. The clip on the moving cable pushes the pendulum along in the direction of the travel of the cable and out from the partition and thus opens up the front of the loader box and lets the contents pour into the carrier. Both the loader box and ore carrier move together at the same speed for a sufficient distance to allow the ore to be discharged from the loader box into the ore carrier. The swing of the pendulum raises it sufficiently high to clear the rope clip and the pendulum with its loader box swings back in between the guide and the bulkhead ready to receive another load of ore from the ore bin.



Side Elevation. Sectional End Elevation.

AUTOMATIC LOADING APPARATUS FOR WIRE ROPE TRAMWAYS.
Designed by A. S. Hallidie. Manufactured by the California Wire Works, San Francisco, Cal.

It is claimed that with the aid of one man the device will easily load 300 tons of ore in 12 hours. The apparatus is very simple, has but few wearing parts and is not apt to get out of order. It is manufactured by the California Wire Works, 330 Market St., San Francisco, Cal.

A GASOLINE PUMPING PLANT FOR A TOWN WATER SUPPLY.

The new water-works at Gibsonburg, O., which were completed in November, 1897, take their supply form a 10-in. well, 385 ft. deep, drilled in the limestone formation. The pumping plant consists of a Springfield gasoline engine of 40 HP., driving a Gould's triplex pump of 750,000 gallons daily capacity, and another Springfield gasoline engine of 15 HP., driving a double-acting deep well pump. The larger engine is intended for direct pressure for fire service, and the smaller engine maintains the supply in the service reservoir and stand-pipe. The service reservoir is circular, built of brick and roofed over, and has a capacity of 84,000 gallons. The steel stand-pipe is 13 ft. diameter and 110 ft. high, with a timber roof, and has a capacity of 109,000 gallons. The distribution system comprises about 4½ miles of 4, 6 and 8-in. cast-iron pipe, 46 double-nozzle hydrants and 28 valves. There is little in the construction of the works that calls for special mention, except perhaps the fact that every foot of the trench work was rock excavation, the top soil being used for back filling immediately around the pipe. The engineer was Mr. Burton J. Ashley, of Chicago, and the general contractors were W. D. Boyce & Co., of St. Louis, Mo. The cost of the works was about $25,000.

The most interesting feature about the plant was the installation of a large gasoline engine for fire service, at a first cost of about $1,000 more than a steam-pumping plant of the same capacity. The original specifications provided for a compound, non-condensing, duplex, direct-acting steam pump of 750,000 gallons capacity; a deep-well pumping engine, and two horizontal tubular boilers of 60 HP. Some of the oil wells in the neighborhood, however, have their pumps operated by gasoline engines, and the water-works trustees, therefore, inserted a clause in the specifications stating that bids would also be received for a gasoline pumping plant. As this was not done until after contractors had become aware that a steam plant had been specified, there was little chance of competition for a gasoline plant, and, consequently, in view of the fact that the trustees were known to be favorable to the latter, an attempt was made to get a high price for such a plant. At the last moment, however, a much lower bid for a gasoline plant was put in, and this was favorably received by the trustees. The engineer preferred a steam plant, mainly for three reasons: (1) That a gasoline engine must always be run at its full capacity; (2) that little was known as to the operation of gas engines as large as 40 HP.; and (3) the possibility of a failure to get the engine promptly started on an alarm of fire. The trustees, however, were in favor of the gasoline plant, and as the engineer did not take a position in opposition to such a plant, the principal question to be considered before awarding the contract was that of securing a sufficient guarantee for the protection of the city.

The guarantee submitted by the bidder was not strong enough to be satisfactory, and the engineer was requested to prepare a form of guarantee. In doing this he purposely inserted a clause which represented, almost word for word, a statement or claim made in the bidder's catalogue. This was considered by the gas engine representative to be entirely too strong, until his attention was called to the printed catalogue, and eventually, after much discussion and some slight modification, the guarantee was accepted by the engine builder's representative, the pump-maker, and the general contractor, each one being held responsible. When the engine builders, however, learned of the form of guarantee, they refused to accept it, and the idea of using their engine was abandoned. Another gas engine builder, however, accepted the guarantee, and this engine was adopted.

In view of the development of the gas engine industry in this country, and the application of gas engines to various classes of work, it will be of interest to give the wording of the guarantee. It is to be remembered that the three parties on the one side (the general contractor, the engine builder and the pump builder), "jointly and severally" made the guarantee. The sum of $1,086 mentioned is the sum in excess of the lowest bid for a steam plant. The form of guarantee is as follows:

> That said engine shall develop the amount of 40 HP. under brake test. That the engine shall be free from all defects in both material and workmanship. That we, the makers or contractors aforesaid, will furnish free any parts showing defects within the space of one year.
>
> That the life of this engine will be at least five years if it is properly cared for. That it will do its work economically and without repairs or shut downs under the most trying conditions when given ordinary attention.

That its certainty of starting and operating against the fire pressure named in the regular water-works specifications shall not fall below 100% of reliability, if connected to the pump by friction clutch.

We therefore hereby covenant and agree with the village of Gibsonburg, O., that in the failure of this engine to be, to do or perform any of the requirements hereinabove stipulated, we, or either of us, either jointly or severally, will, at the option of the village, remove such engine and entire pumping plant operated with gasoline power, refund the price paid for such plant, being the amount of $3,702, together with the amount of such damage or loss as may be caused by such non-performance or operation as stipulated herein.

Or, the Board may require of said makers or contractors, jointly or severally, to remove said gasoline plant, as above stated, and install a steam plant, according to the plans and specifications of Burton J. Ashley, Engineer, and pay to the village of Gibsonburg, in addition, the sum of $1,080.

As already stated, one of the principal objections held by the engineer was in regard to its possible inefficiency for fire service, and it is interesting to note that the engine was put to the test a few days before the plant was supposed to be in running order. A fire broke out in a block of tumble-down and inflammable frame buildings and threatened to extend to more important blocks. The stand-pipe was empty and the mains had not been flushed, though they had already been filled with water. Nobody knew how to handle the necessary valves at the pumping station, except Mr. Ashley (the engineer), and the engine contractor's foreman, who still had charge of the machinery. The contractor accepted the responsibility of running the plant, and while the man in charge started the engine by hand power (the compressed-air starting apparatus not having been fitted at that time), Mr. Ashley, who had hurried to the station on hearing the fire alarm, opened the valves. Although fully 15 minutes elapsed between the time of giving the fire alarm and getting pressure on the mains, the fire was confined to the old block in which it started, and was got under control after having done damage amounting to about $75,000. The value of water-works for fire protection was thus forcibly impressed upon the town.

THE BERTHELET SEPARATOR AND THE CAMPBELL KILN IN CEMENT MANUFACTURE.

During a recent visit of a member of the staff of Engineering News to the works of the Milwaukee Cement Co., at Milwaukee, Wis., two interesting features of the plant which attracted special attention were the Berthelet separator and the Campbell kiln, and particulars of these are given below, from information furnished by Mr. J. R. Berthelet, Superintendent of the works.

The separator is a broad shallow inclined chute of rectangular section fitted with a series of screens of wire cloth of coarse mesh made with heavy wire, giving the results otherwise attained by a finer mesh and smaller wire. The wire cloth is only covered by the fines, and the coarse particles not in direct contact with the cloth are kept in active agitation, causing a vibratory action on the screen. This enables the fines to pass through the meshes of the cloth, and avoids the difficulty of clogging and filling. The material must be dry, and at least 25% of the product entering the separator must be coarse, as the coarse particles are made the active agent in effecting the separation.

Where dry material is to be reduced to powder by grinding, it has usually to be passed through two separate mills to be reduced to the required degree of fineness. A considerable portion of the material, however (sometimes 25% or more), is reduced to the required fineness in the first mill, and it involves unnecessary expense and power, with reduction of capacity, to pass this proportion of the material through the second mill. With the Berthelet separator arranged as shown in Fig 1, the product from the first mill or crusher (A) is delivered into the elevator boot (B) and elevated to the head (C), from which it passes by gravity into the separator. The fines (or finished product) pass directly to the packing chute (D), to be delivered directly into the barrel or sack. The tailings pass to the second mill or disintegrator (E), the crushed product from which passes again to the elevator boot (B). In this way the capacity of the plant is greater than it would be if all the product from the first mill was passed through the second mill. At the Milwaukee cement works the separators have reduced the cost of grinding fully 50%, while at a gold ore mill they have increased the capacity of the plant 15%.

These separators require no machinery or power, and a number of them are in use for cement, crushed limestone, gold ore, mineral paint, etc.

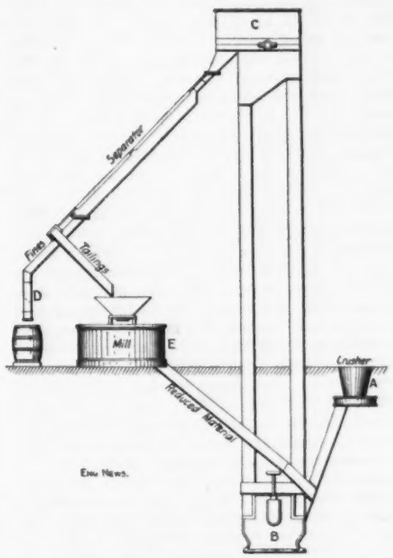


Fig. 1.—Application of the Berthelet Separator at the Works of the Milwaukee Cement Co.
J. R. Berthelet, Superintendent.

In one case, with mineral paint, the first crushing gives 40% of fines and the second separation gives 30% of finished mortar color. The capacity of the separator is about 5 tons per hour of any dry material, where the requirements are not over 50 mesh fine.

The Campbell lime and cement kiln, Fig. 2, is made by H. Campbell & Sons, of Milwaukee, Wis., and was patented in October, 1897. It differs from the old style of kiln only in the construction of the lower part, or "pot." Instead of being a continuation of the brick lining, in the form of the base of an egg, it is an open grating in the general form of an inverted cone. The openings in the grating are so arranged that they are kept open for the admission of air by the descending mass sliding over them. The space between the outside of this grating and the inside of the brick casing is accessible to the operator.

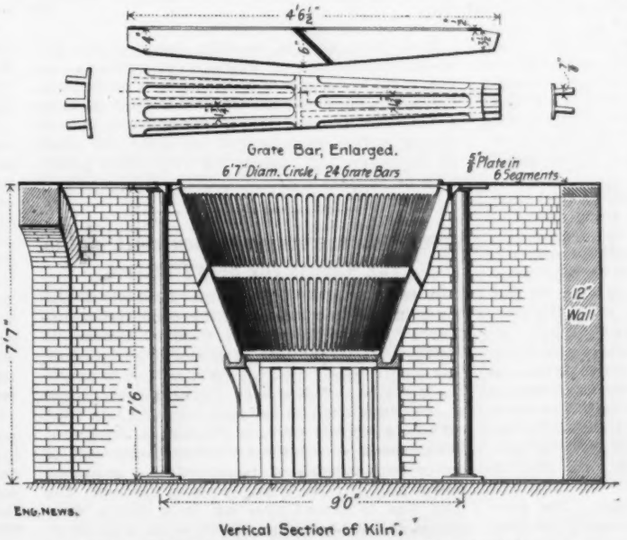


FIG. 2.—THE CAMPBELL KILN; MILWAUKEE CEMENT CO.

It is claimed that two years of use have demonstrated that it gives more uniform results with less half-burnt rock and clinker and less fuel consumption than the ordinary kiln, owing to the ample provision for a uniform draft distributed through the entire mass, and not localized, as in the case of an ordinary kiln having an opening only at one side of the base. A test run of one month was made at the works of the Milwaukee Cement Co., with a kiln 36 ft. high, 7 ft. 6 ins. diameter at the top and 10 ft. diameter at the highest part, and the product of this kiln and the ordinary kilns was graded as 1, good; 2, fair; 3, bad; 4, very bad. The Campbell kiln showed a "grade of burn" of almost uniformly No. 1, the average daily output being 153.93 barrels, with 20.33 lbs. of coal per barrel of cement. The average "grade of burn" of all product of the other kilns was 2.7.

The device can be applied to any kiln, and the cost of reconstruction at the iron-cased kilns of the Milwaukee Cement Co. has been $250 per kiln, while for a stone kiln the cost of reconstruction would be somewhat higher. A new Campbell kiln would cost somewhat less than a new kiln of the ordinary pattern, the iron "pot" displacing more than its equivalent value in brick and labor. The Milwaukee Cement Co. will reconstruct all its 29 kilns on this plan.

ELEVENTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION.

The Interstate Commerce Commission's eleventh annual report, the advance sheets of which have just been given to the press, is devoted mostly to a consideration of the effects of recent court decisions upon the powers and the work of the commission. The decisions of the courts upon the Import and Export Rates case, the Social Circle case and the Maximum Rates case are discussed at length. In respect to the Maximum Rates decision we have seen nowhere a clearer statement of the confusion that would ensue if it were once established that the question as to what are reasonable rates should be relegated to the overworked United States circuit courts, and complainants suing for damages for alleged unreasonable rates should be permitted to bring suit before a jury. We commend the following paragraphs of the report to the railway managers who are just now of the opinion that their interests would be safer in the hands of these courts than in the hands of the Commission:

> Damages for unreasonable rates can only be recovered by the one who pays the freight money, while the real loser is generally the producer or consumer. Moreover, if the party injured could sue, his individual interest in the particular case would usually be small, and he frequently would not do so. An individual is not ordinarily a match for the vast power of a railroad corporation. Reparation had only been awarded by the Commission in five cases. This shows how insignificant to those who suffer and complain is the mere right to recover a portion of the freight paid. Cases involving unreasonable rates have usually been brought by a State Commission, a freight bureau, or by the Interstate Commerce Commission, on its own motion, with a view of correcting the rate schedule to be in future effect, but such bodies would not conduct investigations which could only establish purely personal rights. When the case for recovery of damages gets to the court it involves a jury trial. On grain from Kansas City to Chicago, a Chicago jury may think 20 cts. per 100 lbs. reasonable, while a Kansas City jury may think 15 cts. enough. A cardinal purpose of the act is to secure uniformity of rates, but application of the remedy provided by Congress produces, under the Supreme Court decision, not uniformity and equality, but the direst confusion and grossest discrimination.
>
> Claims based on unreasonable rates may come to be bought and sold, prosecuted upon speculation, in much the same way that personal damage claims are, and juries will give the like excessive verdicts that they often do in suits of that nature. Does the United States government desire deliberately to create that condition of things which is a little better than legalized brigandage? Instead of saying that the Commission can only regard the past,

it would accord more with the intent of the act and be more for the interest of the public and the carriers if inquiries by the Commission looked mostly to the future. The power to reduce a rate has been and will be, if granted, a most important feature of the Commission's work. Over one-third of its orders have directed rate reductions. In 38 cases now pending the main question is one of reduction of rates. Four of these cases effect the most important interests in widely separated sections of the country, and the amounts involved in the reductions asked are enormous. There should be some tribunal to decide these questions, and, unless some better way can be devised, the Commission should have power to prescribe rates in the future, as it has assumed to do in the past.

The report goes on to say that without power to regulate rates the Commission is powerless to prevent discriminations. It is further pointed out that the decisions of the Supreme Court have practically nullified the section of the law known as the long and short haul clause. In regard to the question of pooling, it is stated that the Commission is not agreed upon the wisdom of such legislation. A law prohibiting ticket scalping is urged, and in conclusion it is recommended that a thorough revision of the Interstate Commerce law shall be made.

A NEW SECTIONAL GUN.

The sectional gun which is illustrated in the accompanying cuts has been designed to avoid the use of the great pieces of steel used in the construction of large modern guns of the ordinary type, and to avoid the uncertainty as to the strains in such large pieces, especially with hoops heated and shrunk on. It is also claimed that by this sectional construction the life of guns will be greatly increased, since the inner tube can be removed and renewed, and the body of the gun is not liable to deterioration, for the seams between the rings prevent the setting up of continuous and destructive vibrations. The transportation and erection of guns would also be greatly facilitated. The general appearance of the gun is shown in Fig. 1.

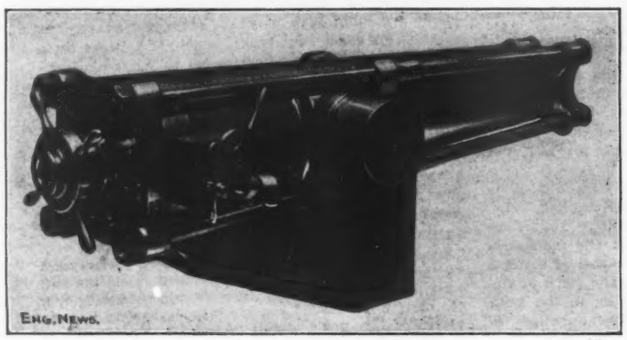


FIG. 1.—VIEW OF BLOOD'S SECTIONAL GUN.

The gun consists of a series of rolled steel rings, or rather bored disks, the boring being done to a taper to fit the taper of the inner rifled steel tube. These disks are fitted in position by means of dowel pins, and are held together by four longitudinal rods with threaded ends passing through lugs on the end pieces of the gun, while the disks of the breech portion are also held together by four taper bolts fitting bored holes in the disks, and drawn tight by nuts on the outside. When the disks or sections are assembled, the rifled tube is inserted and driven home, and the initial strain is set up by forcing it into its final position by hydraulic pressure. The pump used for this purpose has an indicator showing the force applied, so that the amount of the strains set up in the body of the gun can be seen at once. The bore of the disks and the exterior surface of the tube can be turned to an exact fit, but if desired a thin tube of soft copper may be fitted to the steel tube to ensure absolute uniformity of bearing between the disks and the tube. When the steel tube becomes worn or powder-burned it can be loosened by a hydraulic jack applied at the muzzle, as the tube exteads slightly beyond the end of the body of the gun, as shown in the section, Fig. 2. A new tube can then be fitted.

A special feature of the gun, apart from its sectional construction, is the arrangement of the breech, the closing piece having an uninterrupted screw and yet requiring only a slight movement to release the breech block. Ordinarily, in large guns, the breech block swings on a vertical hinge and has an interrupted screw thread (cut away longitudinally) so that it will not require a large number of turns to send it home. In this gun the breech block slides laterally in a chamber across the breech and the breech screw merely forces it tight against its seat. When the gun has been fired, the screw is turned back slightly, releasing the block, which is then pulled out at the side of the gun. The steel tube or sleeve in the breech, which is shown withdrawn in Fig. 2, is then pushed in, as at Fig. 1, and the cartridge is passed through it into the chamber at the rear of the bore, the rim of the flat end of the cartridge projecting slightly outside the rifled tube. The sleeve is then withdrawn, and the breech block slid back, a circular recess in its face fitting the flat end of the cartridge. The steel screw is then turned, pressing the breech block tightly against the end of the cartridge and the rifled tube, and thus forming a gas tight joint. A bolt in the head of the gun engages with a groove in the back of the breech block, and forms a gage to ensure its being in proper position. The gun is then fired by the lock shown in the end of the breech block, the screw reversed, the breech block slid out, the sleeve pushed in and the cartridge removed.

The gun is the invention of Mr. Edwin J. Blood, of Chicago, and is being handled by the American Sectional Cannon Co., New York Life Building, Chicago, of which Mr. Duane Doty is consulting engineer. The right to manufacture the gun in Europe has, it is stated, been secured by an English company, which sent out military experts to examine the model gun built under the direction of the inventor.

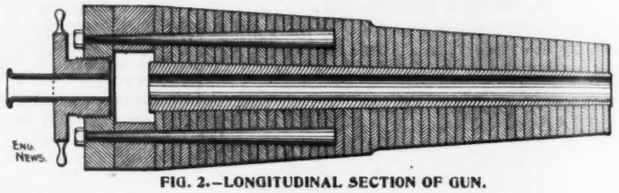


FIG. 2.—LONGITUDINAL SECTION OF GUN.

It seems to us that the chief defect in this gun would be its lack of longitudinal stiffness. In the early experiments with wire wound guns, trouble was experienced with the droop of the muzzle until an external jacket was adopted, and we should suppose something of the same sort would be necessary here, unless for very short pieces, such as mortars.

RESULTS OF THE RECENT FRENCH TRIAL OF MOTOR WAGONS FOR HEAVY TRAFFIC.

In its issues of Nov. 20 and 27, "Le Genie Civile" gives in full the report of the commission, appointed by the Automobile Club of France, to conduct the recent test of heavy motor-wagons. The report takes up each type of vehicle in detail; but it will be sufficient here to give the conclusions of the commission as deduced from the late trial.

The Automobile Club, of France, in November, 1896, issued a call for an international test of motor cars capable of transporting a minimum useful load of 1,000 kilos., or about one ton. The trial was to extend over six days over a total course of 300 kilometers, or 186 miles, with varying grades, and over both paved and macadamized roads. The commission appointed to superintend this test was to particularly note the following features: The consumption of fuel, kindling, lubricants, etc.; the speed upon the level and upon grades; the time consumed in coming to a full stop under the action of brakes; the ease of management or control, quickness of reversal of motion, security and comfort, expense of operation, first cost, and the importance, frequency and comparative ease of necessary repairs. Of the 15 motors entered for the race, only seven successfully withstood all the requirements of the commission's tests. The seven successful types were grouped as follows for the transport of passengers: Steam, the omnibus Scotte and the omnibus Dion & Bouton; petroleum, the omnibus Panhard & Levassor; motor-truck, steam, the carriage Dion & Bouton; motor with trailers, steam, Scotte type. In a second class of vehicles intended for the transport of merchandise, were the petroleum vehicle of Dietrich & Co., and the Scotte steam motor with trailers.

Omitting the very detailed description of the tests of each type of motor, we have summarized the conclusions reached by the commission in tabular form herewith.

It is remarked that the net cost recorded in the table only applies to vehicles operated under conditions comparable with those of this test, in speed, grades, etc. If the builders of the motors had better appreciated the true purpose of the test, some of these figures would doubtless have been more advantageous to them. The commission concludes, however, that with the figures here given mechanical traction upon highways is an assured fact, and that both passengers and goods can be thus transported with notable profit.

In proof of this statement the following comparison is made: Assume that a service of this kind is established between a railway station and some place 15 kilometers, or 9.3 miles distant. Assume a daily traffic of 40 passengers with hand baggage, and also about 8 tons of merchandise, with some trunks. The regular schedule of charges for tramways would fix the following prices:

	Francs per kilo.
For first-class passengers	0.10
For second-class passengers	0.06
Per ton of trunks, etc., transported	0.36
First-class merchandise	0.16
Second-class merchandise	0.14
Third-class merchandise	0.10
Fourth-class merchandise	0.08

But this charge for merchandise is much exceeded by some recent tramway schedules; that from Vals-les-Bains to the Aubenas station charges from 0.40 francs to 0.25 francs for 1st and 4th class merchandise.

An automobile vehicle would, in comparison, make each day three round trips, or 90 kilometers, or 55.8 miles, in total. With 10 or 12 places for passengers, and with an average of two-thirds of the seats filled, the passenger traffic would equal about 40 daily. A vehicle capable of transporting 3 tons, but working most effectively with 2 tons as an average load, would be able to make two round trips, or 37.2 miles, per day; and thus would carry the supposed average traffic of 8 tons between the two points. Under these conditions, and according to the table given, the daily receipts would be 5.17 francs per kilometer run; and the annual receipts would be 1,887 francs for each kilometer of the daily run.

In the case of a tramway, under the ablest administration, these receipts would just about cover the expense of operation. And as the interest and sinking fund on the first cost of building the line could not be taken at less than 4% on 30,000 francs, there would be really only about 600 or 700 francs per kilometer to devote to operation on the tramway, in comparison; or 1,887 — 1,200 francs. On the other hand, the accompanying table shows that with a regular service of motor wagons, the data here assumed would yield a profit of about 0.80 francs per kilometer run; corresponding to 12 francs per day if the runs were 15 kilometers, or a profit of 4,380 francs per year.

The capital invested in such a service would be about as follows:

Recapitulative Table Showing Net Cost per Kilometer for the Transport of Passengers, with or without Hand Baggage, with 62 lbs. of Trunks, Etc., and per Ton of Merchandise.

	Passengers.								Goods.	
	Steam.				Steam.					
	Scotte.	Dion & Bouton.	Petroleum. Panhard & Levassor.	Dion & Bouton, motr trk.	Scotte, trailers.		Petroleum. Dietrich & Co.	Steam. Scotte, trailers.
Horse-power, French	14	25	12	35	16		6.5	16
Useful loads, lbs.	2,640	2,464	2,200	5,500	5,500		2,640	9,240
Commercial speed, miles per hr.	6.5 to 6.7	8.7 to 9	6.2 to 6.5	6.2 to 6.7	6.2 to 6.5		5 to 5.6	4 to 4.3
Daily course run, miles	68.2	90	65	67	65		56	43.4
	Net cost in francs per kilometer							
Load.	A	B	A	B	A	B	A	B	Per metric ton.	
Half load	0.110	0.079	0.089	0.063	0.122	0.087	0.067	0.048	0.070	0.050	0.597	0.570
Two-thirds load	0.057	0.040	0.045	0.032	0.064	0.046	0.034	0.025	0.036	0.026	0.317	0.297
Full load	0.039	0.028	0.030	0.022	0.045	0.032	0.023	0.017	0.025	0.018	0.230	0.206

Note.—Column A indicates a traveler with 62 lbs. of baggage; column B indicates a traveler without any baggage. With animal traction, the Commission figures the kilometric cost of transporting a passenger, with or without baggage, at 0.10 to 0.12 francs; for the transport of a ton of merchandise on rails, they put the cost at 0.30 francs per kilometer.

	Francs.
1 motor-omnibus accommodating 10 or 12 passengers	22,000
1 freight motor-wagon of 3 tons capacity	20,000
1 reserve vehicle, mixed	21,000
Total	63,000

It should be remarked that the annual profit of 4,380 francs, already figured out, is net profit, as the interest and sinking fund was included in the tabular statement. In this case, too, there would be no subvention, or subsidy necessary.

Among the advantages of the motor-wagon service, the commission points out the case where the traffic of the line would not warrant the expense of laying rails. The motor carriage has the further advantage of not being fixed to the ground, and thus being fated to die with the loss of traffic or change in conditions; it is always ready to establish a new regular service in some other direction if the route where it is in service proves unprofitable.

The commission announces that a further test of motor-wagons of this class will be held in October, 1898, and it sends out these full details in the hope that they may benefit the competitors in preparing for the next trial.

PROGRESS ON THE NEW HOLYOKE DAM has been slow during the past season, owing to high water in the river. The dam was described at length in our issue of May 13, 1897. Most of the masonry has now been carried up to elevation 75, the crest of the dam being at 100. One of the abutments has been carried up to 80 and the other to 85 ft., their top being at elevation 112. In other words, the bottom work is pretty well along, except at the channel openings. The contract was let in February, 1895, to the Fruin-Bambrick Construction Co. and Henry S. Hopkins, of St. Louis. In November, 1897, it was transferred to Mr. Arthur McMullen, of New York city, who has recently finished a large contract in the Croton drainage area. The original contractors accepted Mr. McMullen's proposal to take up the Holyoke work largely because they had so much other work in hand, including heavy railway contracts in the West and a large amount of asphalt paving contracts. We are indebted to Mr. W. H. Swift, President of the Fruin-Bambrick Construction Co., St. Paul Building, New York city, for the above information. The dam is being built for the Holyoke Water Power Co., of which Mr. Edw. S. Waters is Chief Engineer and Treasurer.

THE STETTIN FLOATING DOCK, under construction by the Vulcan Ship Building Co. for the service of the Bremen Lloyd Co., will be 520 ft. long, 82 ft. wide and 24 ft. deep on the sill. The normal capacity is 11,000 tons. This dock will be used in cutting in two and lengthening some of the steamers of the Hamburg-American Line.

A SHIP FOR ARCTIC EXPLORATION has been presented to R. E. Peary, C. E., U. S. N., by A. C. Harnsworth, owner of the London "Daily Mail" and other journals. This ship is the "Windward," used in 1894-5-6, in the Jackson-Harnsworth exploration of Franz Josef Land and the search after Gillies Land, an expedition equipped by Mr. Harnsworth at a cost of $125,000.

THE LAKE SUBMARINE WRECKING BOAT, designed by Simon Lake, of Baltimore, and built by the Columbian Iron Works, of that city, was successfully tested, on Dec. 16, in the Patapsco River. This vessel, the "Argonaut," is designed for the purpose of finding sunken vessels and removing their cargo. In the trial this boat, only 29 ft. long, and cylindrical in form, was submerged in 10 minutes and then run from one side of the river to the other on the bottom on three corrugated wheels driven by gasoline engines. The rear compartment of the boat contains gasoline engines, a dynamo, and air and water pumps; the two forward rooms form an air-lock, through which a diver can pass out of the vessel and work on the bottom. The boat is sunk by admitting water to three chambers provided, and compressed air enables the men to remain below the surface for several hours. The vessel is owned by the Lake Submarine Co., of Newark, N. J.

THE HISTORY OF THE "NEW IRONSIDES" was briefly given by Mr. Chas. H. Cramp in a late address before the Contemporary Club, of Philadelphia. This ship was contracted for at the same time that the building of the original "Monitor" and the "Galena" was decided upon by a naval board consisting of Commodores Paulding, Smith and Davis. The "New Ironsides," completed in 1862, was 240 ft. long, 58½ ft. beam, drew 15 ft. of water, was rated at 3,250 tons and had engines of 1,600 HP. Her hull was made of oak frames, solid together on the sides, and covered with 12-in. oak; outside of this was 4½ ins. of hammered scrap-iron armor, made at Pittsburgh and at Bristol, Pa. Her armament was made up of fourteen 11-in. Dahlgren smooth-bore guns, and two 200-lb. Parrot rifles, all muzzle loaders. The contract was awarded to Merrick & Sons, of Philadelphia, for $848,000, and the plans and specifications were made by Mr. Cramp, and the contract for the hull and fittings was sublet to his firm. This battleship was built under great difficulties, with the wood entering into her construction growing at the time of contract and with no precedent in type or special tools ready for the novel demand. Yet, in 11 months and 2 days after signing the contract this ship was in battle before Fort Sumpter. Mr. Cramp called attention to the fact that she was struck by projectiles more than 70 times in one day, was struck several hundred times in all and withstood the explosion of a torpedo against her side, without material damage. She was the first battleship to fire a gun at an enemy and she fought more battles than all the ironclads, past and present, put together. This famous warship was unfortunately destroyed by fire at League Island Navy Yard in 1866.

A CIVIL SERVICE EXAMINATION for architectural draftsmen will be held Dec. 29 by the Department of Public Works of New York city. The candidates will be required to have special knowledge in the construction of fireproof buildings. Mr. S. William Briscoe, New Criminal Court Building, New York, N. Y., is the secretary of the civil service commission.

MOTOR WAGONS IN FRANCE are briefly reported upon by U. S. Consul H. S. Brunot, of St. Etienne. After speaking of their rapidly growing popularity on the good roads of France, he gives the present trade-price of these vehicles as ranging from $900 for a two-seated carriage to $1,200 for a six-place wagonette, or a delivery van. The sum of $40 to $120 additional is charged for rubber tires. The more common motor is one fed by petroleum, of 700 specific gravity, costing 9 cts. per quart. The estimated running cost is about 1 ct. per kilometer, or 1.6 cts. per mile. At the present time 14 electric cabs are said to be doing good service on the streets of London.

ACCUMULATORS FOR MECHANICAL TRACTION are discussed in "L'Industrie Electrique," for Oct. 25, 1897. A writer in this journal attempts to determine the relative weight of the most advantageous accumulator to be used, with a given speed, on the longest course and with the maximum useful weight advisable. He shows that the accumulators should never exceed in weight 50% of the total weight of the vehicle, and that it is difficult to descend below 25% of this weight. To obtain a speed of 18 kilometres, or 11.6 miles per hour, on a level, requires the expenditure of 1,800 watts per kilometric ton of 2,204 lbs. With the accumulators actually in use it requires about 11 lbs. of accumulator to store 100 watt-hours, and 660 lbs. of accumulator to haul one ton under the above conditions.

THE LEASE OF THE WEST END STREET RY. to the Boston Elevated Co. has been approved by the Massachusetts R. R. Commission under the revised terms submitted by the two corporations after the former lease had been rejected by the Commission. The lease is for a 25-year term, and the dividends guaranteed to West End stockholders are 8% on preferred and 7% on common stock.

THE PROPOSED MUNICIPAL GARBAGE DISPOSAL plant at Milwaukee, noted in our issue of Dec. 9, is rendered impossible for the immediate present, owing to the fact that the law under which $120,000 of bonds for the plant were to be issued has been declared special legislation, and therefore unconstitutional. On Aug. 25, 1897, the old contract for garbage collection and disposal expired. The contractor was the Wisconsin Rendering Co., which for five years had transported the garbage to a point on the lake shore and there treated it by the Merz reduction system, as described in our issue of Nov. 1, 1894. Not long ago a contract was awarded to Crilley & O'Donnell, who offered to collect the garbage and dispose of it outside the city limits for a period of five years for a total of $324,500, or within the city for $274,500. This firm proposed to use the Holthaus reduction system. It did not execute the contract. At the same letting the Wisconsin Rendering Co., with collecting, transporting and disposal plants already established, bid $368,750 for the work. The next to the lowest bidder was Cooper & Burke, who offered to do the work for $300,000, without regard to the location of the disposal plant. Instead of accepting this bid, authority was secured to issue bonds for the construction of disposal works by the city. This scheme has fallen through, as stated above. Meanwhile the garbage has been handled by the health department. Recently there has been much trouble over final disposal. Arrangements were made to dump the garbage on a farm in the town of Wauwatosa. The board of health of that town has taken legal steps to prevent this. It also ordered the owner of the land to cover the garbage with dirt and on his failure to do so the board has been covering it, expecting to collect the expense of the work from the owner of the land. This experience at Milwaukee is but another example of the unsatisfactory condition of garbage disposal in this country, as commented upon in our issues of Nov. 4 and 11.

THE PRODUCTION OF PIG IRON has now increased to the maximum rate that has ever been attained in this country. The "Iron Age's" monthly report of capacity of furnaces in blast gives a weekly capacity of 226,024 gross tons. This corresponds to an annual production of over 11,750,000 gross tons.

THE CONSOLIDATION OF THE WIRE AND WIRE rod works of the country into one great corporation, which has been reported in the daily press as having been effected, is, according to the "Iron Age," still a matter of negotiation. It says that the leading concerns have given an option on their properties until March 31, and that the valuations placed on the plants are now being examined by appraisers, and the books for the last three years are about to be examined by auditors.

THE MESABI IRON MINES, of the Lake Superior regions, say Messrs. E. J. Longyear and C. E. Bailey, in the Transactions of the Am. Inst. Mining Engineers, in the fifth year of actual mining has 8,000,000 tons of ore to its credit, with an additional 3,000,000 tons estimated for 1897. This output is accounted for by the existence of the ore in flat beds, usually near the surface. The ore analysis shows about 60.8% iron and from 0.08 to 0.09 phosphorus. In thickness the beds vary from a few feet to over 300 ft.; but in rare instances exceed over any large area 150 ft. of continuous high ore. The top ore is usually poorer in quality, being especially high in phosphorus; and the side walls, bottoms and ends show a lower percentage of iron and higher phosphorus. The best ore is thus in the heart of the deposit. The ore itself is a soft hematite, and in some cases it may be drilled with an auger or loaded by a steam shovel without blasting. The surface material is glacial drift, from 10 to 150 ft. thick, with granite boulders, and exceedingly hard to handle. The side walls and underlying rock is taconite. Owing to increased experience and improved appliances the cost of stripping has decreased from 50 to 30 and 35 cts. per cu. yd. In underground work a single shaft at the Fayal mines hoisted 57,000 tons of ore in one month in 3-ton skips. In steam shovel work the Mountain Iron mine has the record, with 5,800 tons excavated in 10 hours, and 164,000 tons in one month.

ANGLO-AMERICAN TRADE STATISTICS are discussed in a late issue of the "London Statist," and the figures there presented show that the import of American goods into England for 1897 will probably exceed by $400,000,000 the value of British goods exported to America. In 1887 the imports into England exceeding the exports to the United States by $214,000,000; consequently, this balance has almost doubled in ten years in favor of the United States. The estimated value of the imports by England for 1897 is given as $575,000,000, against $175,000,000, in the value of British goods bought by the United States.

AN INTEROCEANIC SOUTH AMERICAN RAILWAY is to be made the subject of a conference between Brazil, Bolivia, Peru and Chili, says "Le Genie Civil." This line would start at Rio Janeiro, pierce the Andes by a tunnel and abut upon the Pacific. The end sought would be the uniting of the political and commercial interests of the several states by an exchange of products only possible with some more rapid means of intercommunication than now exist. In Bolivia more than a million people at the present time transport their products on the backs of mules down a descent of about 13,000 ft. to the sea level at Valparaiso. The distance from Rio Janeiro to Antofogasta would be, by the proposed railway, about 2,133 miles, and

the trip could be made in four or five days, instead of 45 days by the present sea route. The distance from Rio Janeiro to Callao would be about 2,480 miles. It is estimated that the railway could be built in 9 years from the day of beginning, but no estimate of cost is furnished.

AN ORIGINAL PRETEXT FOR A RAILWAY comes from China. "The Indian and Eastern Engineer" says that the Imperial Household Department has lately memorialized the Throne, asking for permission to build a light railway between Peking and the Imperial graveyard. Under present conditions, every time a member of the Imperial family, or of the harem, dies it costs from 300,000 to 2,000,000 taels for transport expenses, the latter figure representing the sum usually expended for a deceased Emperor, or Dowager Empress. Just what part of this sum the building of the railway would save is not stated; but the plea for the road is made on the score of greater economy in this connection.

BOOK REVIEWS.

THE WEALTH AND PROGRESS OF NEW SOUTH WALES—1895-6. By T. A. Coghlan, Government Statistician. Vol. II. Sydney, N. S. W., 1897. Stiff paper, 8⅛ × 5¼ ins.; pp. 403-1,030.

The first volume of this publication was reviewed in our issue of Oct. 15, 1896. The present volume treats of the population, vital statistics, instruction, social condition, industrial and pastoral history, foods, public and private finances, local government, etc., of New South Wales. At the end of 1896 the population of New South Wales was 1,297,640, and that of the seven Australasian colonies was 4,323,148; the latter population has grown from 1,265,898 in 1861. The three chief cities of these colonies, Sydney, Melbourne and Adelaide, have populations of 410,000, 448,410 and 145,212 respectively. The net value of the industrial productions of New South Wales in 1891 was $155,897,600, about one-third of this coming from pastoral industry and nearly $40,000,000 from manufacturing and allied processes. Under the head of finances we learn that from 1886 to 1896 inclusive the appropriations for the public service amounted to $520,152,370, while the actual revenue for the same period was only $485,697,410. Fortunately, the expenditure incurred was less than the appropriations; though the actual excess of expenditure above income was serious enough, amounting to $7,187,975 for the years 1886-91, and that for the remaining years are not stated, as the expenditure accounts are not yet closed. Mr. Coghlan says that much of this deficit is chargeable to the peculiar manner in which the public accounts are kept. Under the head of revenue for 1896, the total custom receipts amount to about $9,000,000, and the net total revenue from taxation of all kinds, including customs, is $14,472,610. The state railway service yielded a small net profit, after all expenses had been paid, in 1881 and 1882; but since these periods the net revenue has not equalled the interest payable. The report itself, taken in connection with the first volume issued, enters very fully into the details of the status of affairs in New South Wales, and the exhibit is complete and seemingly most fairly handled.

PHYSICAL PROBLEMS AND THEIR SOLUTIONS.—By A. Bourgougnon, formerly Assistant at Bellevue Medical College. Science Series No. 143. D. Van Nostrand Co., New York. 6 × 3¾ ins.; boards; pp. 224; 50 cts.

This little book contains 215 problems, for arithmetical or algebraic solution, relating to various branches of physics, such as mechanics, hydraulics, acoustics, optics, heat, electricity, etc. Brief explanations, rules and formulae for the convenient solution of the problems are given, together, in most cases, with a statement of the problem in algebraic form and the proper answer. The book cannot take the place of the regular text books on mechanics, but it may be of assistance to students in giving them a great number of problems to practise on. There are not a few blemishes in the author's style, but they are not of serious importance if the book is used in conjunction with standard text books. An instance is found in the first page, where the principle of the lever is given as follows:

> The resistance or weight multiplied by the weight-distance is equal to the power multiplied by the power-distance.

The use of such an unfamiliar and inherently objectionable term as "weight-distance" to mean the distance of the weight, or of the point of application of the resistance, from the fulcrum should be discouraged. The use of the word "power" in the sense of "applied force" is ancient and should be obsolete when all standard modern authors on mechanics are agreed in defining power as the rate of work. On page 31 the author makes an entirely unnecessary and confusing distinction between "absolute specific gravity," "relative specific gravity," and "absolute density." The latter he defines as "the mass of the unit of volume of the substance, from the general formula, $W = M \text{ (mass)} \times g \text{ (intensity of gravity)}$." He further says, "We have $w = d\ g$ for the substance." Accepting this, we should have $d = w \div g$ or absolute density = weight ÷ g, which we think is an entirely novel definition of absolute density. In fact, we doubt if there is in mechanics any such thing or conception as "absolute density." The expression "intensity of gravity" as the meaning of "g" is also objectionable. It should be "acceleration due to gravity."

ANNUAL REPORT OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY. 1897. Paper, 9 × 6 ins.; pp. 550 and pp. 34 of index.

The annual report of the Chief of Engineers, U. S. Army, just issued, is more than usually interesting, especially in the line of seacoast defense, so long neglected. Since the inauguration by Congress of the modern system of coast defenses, in August, 1890, the sum of $9,762,333 has been expended upon the construction of gun and mortar batteries. Whereas eight 12-in., 21 10-in., seven 8-in. and two 6-pdr. guns and 80 12-in. mortars had been provided for under earlier appropriations, the present number of emplacements stands as follows: 24 12-in., 82 10-in., 33 8-in., 12 5-in., four 6-pdrs. and 232 12-in. rifled mortars. Twelve of the 12-in. and 77 of the 10-in. guns will have disappearing carriages. During the last fiscal year the number of modern defenses under construction has been increased from 11 to 22, and under the act of June 6, 1896, further new emplacemnts are being built for seven 12-in., 28 10-in., 17 8-in., 2 5-in. rapid fire guns and 24 12-in. mortars; and with the available balance, contracts will be soon made for one additional 10-in. emplacement and 16 more 12-in. mortars will be provided for. The 22 ports where work is now in progress comprise all the more important localities, and those for which defense is contemplated will not require a very extensive or costly armament. By the end of the present working season nearly all the 10-in. and 8-in. emplacements mentioned will be provided with their armament and the 12-in. guns are being rapidly finished. In addition to the forts, casements and cable tanks have been provided for torpedoes and submarine mines, and this work is being continued.

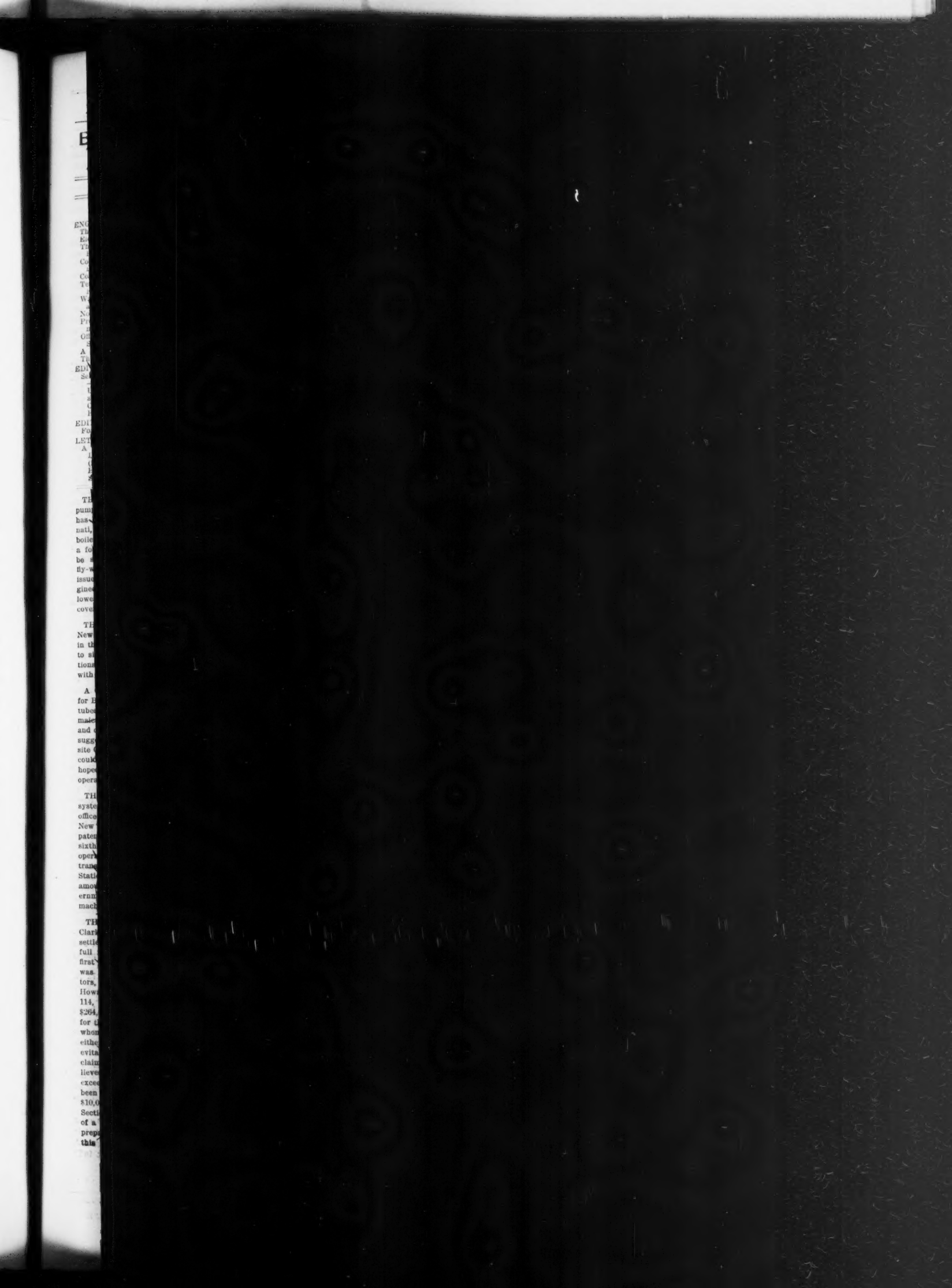
Under the head of River and Harbor Improvements, we find that by the act of June 3, 1896, the sum of $12,634,550 was appropriated for works of improvement and for surveys and examinations. The total expenditure for the fiscal year ending June 30, 1897, and including the work done under the Mississippi and Missouri River Commissions, was $13,461,395. The Chief of Engineers submits a total estimate of $18,098,007 for continuous work in 1899; and for the construction and maintenance of works authorized by Congress, but not provided for by continuous contracts, estimates amounting to $30,630,153 are presented. The work covered by these estimates is given in full detail in the report.

NOTES ET FORMULES DE L'INGENIEUR.—By a committee of engineers under the direction of L. A. Barre and Ch. Vigreaux; eleventh edition, revised and enlarged; Paris, 1897; E. Bernard & Co.; limp cloth; 4 × 7 ins.; pp. 1312; 1,000 illustrations; 11 francs.

The contents of this book may, perhaps, best be explained by saying that it attempts to do for mechanical and civil engineers in France what Trautwine's and Kent's pocket books do for American engineers. The French publication, however, suffers in comparison with the well known American manuals both in typography and in convenience of form. Owing to the large type and thick paper used the volume is nearly 3 ins. thick, which, besides making it unhandy to carry around and use, gives it a squat and unhandsome appearance, which is further accentuated by advertisements printed on the edges and cover and scattered through the preface and table of contents. As far as we have been able to discover without a detailed examination the text of the book is fairly satisfactory. It is, of course, compiled and rearranged from larger treatises and the publications of the technical societies, but this is largely true of all books of this class. For the most part the methods and processes described are those used in France, but English and German practice are given to some extent, although little can be found regarding the practice of American engineers. For the American engineer who may wish to have a brief compendium of French engineering practice the book will doubtless be quite useful, but otherwise the standard American pocket books will be found in all respects preferable. A feature of the book to which the publishers call particular attention is a vocabulary of technical words and phrases in three languages—English, French and German. The possibilities of such a vocabulary are great, as every engineer knows who has had any experience in translating either French or German engineering literature. Whoever had the making of this one, however, not only failed entirely to grasp these possibilities, but knew so little of English that the most ridiculous mistakes in translation are found on almost every page. We find the following samples in glancing over the vocabulary at random: Machine a tarauder—bolt screwing machine, instead of bolt threading machine; travaux preparatoires—dead works, instead of preliminary or preparatory works; eclisse—fishing plate, instead of fish plate; pierre gelive—frost-bitten stone, lampe a incandescence—glowing lamp, etc. These are by no means exceptional examples.

PAVING BRICK TESTS.—Report of the Commission Appointed by the National Brick Manufacturers Association of the United States of America, to recommend standard methods for the conduct of these tests. Commission: D. W. Mead, C. E.; Prof. E. Orton, Jr., E. M.; F. B. McAvoy, W. D. Richardson, Wm. Beahan, D. V. Purington, G. W. Jones. Published by the Association. T. A. Randall & Co., Indianapolis, Ind. Paper; 8¾ × 6 ins.; pp. 110; diagrams; $1.

This report was presented at the annual meeting of the association held at Buffalo, N. Y., in February last, and in our issue of May 6, 1897, a very full abstract of the results arrived at was given, as published in the "Clayworker," the editor of which, Mr. T. A. Randall, is the secretary of the association. But this final report is so full in its investigation of this important subject that we advise all readers interested in paving brick to obtain it for themselves. The abstract already published in this journal shows the care and thoroughness with which the investigation was made, and the standard specifications there given were finally adopted, with the exception of that for conducting absorption tests. A specification for this test was adopted, on slightly different lines from the one in our issue of May 6, but the commission attached to it, as part of its report, a resolution to the following effect: That any paving brick which will satisfy reasonable mechanical tests will not absorb sufficient water to prove injurious in service. They, therefore, recommended that the absorption test be abandoned in all official tests, as unnecessary, if not absolutely misleading. In the standard specification for cross breaking test there is a misprint in the formula as published in Engineering News. It should read $r = \frac{3\ W\ l}{2\ b\ d^2}$. The commission also recommended that both the cross-breaking and crushing tests of paving brick be made optional and not necessary as a proof of excellence. The reasons given for this recommendation were that it was impossible to show any close relationship between the qualities necessary for a good paving material and high structural strength, as indicated by either of these tests. As Prof. J. B. Johnson pointed out, structural strength of a high order is often found in dry press bricks which will not stand frost at all, owing to their lack of bond. The tests for hardness and specific gravity were in like manner abandoned by the commission as unnecessary. All tests have failed to obtain a clue to any relationship between specific gravity and the results obtained in the rattler. As a rule the heavier bricks are better bricks, but not always. The rattler test for paving brick thus remains as the only one which commands general confidence as to its fairness and practical value. The report of this commission was adopted by the national association, at its Buffalo meeting.

LE MECHANISME DU LIT FLUVIAL.—Par V. Lokhtine, Ingenieur des voies de communication. Traduit par A. M. Danzig, Ingenieur des ponts et chaussees, sous la redaction du Bureau Technique International a St. Petersbourg. St. Petersburg, 1897. Paper; 11 × 7¾ ins.; pp. 67; plates.

This is a study of the regimen of rivers based upon the method of direct observation, and it treats in a novel manner many of the more interesting problems in hydrotechnology. The author starts by remarking that in present hydraulic literature we can find the most elaborate study of river currents under special conditions in fixed portions of the course, much about eddies, the helicoidal movement of water, the corelation existing between the depth of the bed at certain stages and its disposition in plan, etc. But we seek in vain for a general description of the physical properties of rivers, explaining the causes of the present state of the entire bed, as contrasted with the cause for conditions in some one part of its course. He then attempts to explain a theory of his own, broadly applied and founded upon the necessary observations made during the execution of public works. Later observations indicate that in some measure his ideas are correct; but, says the author, if it should happen that these ideas are not always in accord with the whole of the complicated mechanism of flowing water, he believes that his work will not be lost, as it will introduce method into the many observations already made. As a basis for his theoretical deductions, he makes this fundamental statement—that every river, considered altogether and not in any particular part of its course, is the resultant of three factors absolutely independent of each other. These are: (1) Its delivery, which is the resultant of climatic conditions and of the soil of the region traversed, as well as of the manner in which the water falling upon the river basin reaches the main river by its effluents. (2) The fall resulting from the relief of the land traversed. (3) Its more or less great destructibility, or the resistance of the bed of the river, as a resultant of the qualities of the strata forming the river bed. These three factors, says Mr. Lokhtine, completely determine the character of the river; they produce all the hydraulic phenomena which we are able to observe in any cross-section of the river; such as the temporary level of the water plane, the quantity passing through any section, the surface fall, the mean and local velocity, the wetted perimeter, the quantity of material carried, etc. All of these phenomena are only the local resultants of the three natural factors cited. The author then goes on at length to the separate study of each of these factors, and then by tables and diagrams, deduced from observations actually made upon great and small Russian rivers, he shows how nearly his theory coincides with the observed facts in each case. He puts forth no special formulas and limits his problem to the general consideration of known phenomena. His study is based upon a uniform system of observation, and he gives the figures necessary for such a comparison as will permit the reader to judge for himself how nearly the ideas set forth are in accord with all the harmonious complexity and the diversified phenomena of river currents of different types. He addresses his work to specialists in the interest of its further development.